BUSINESS RISK MANAGEMENT PROGRAMS AND ON-FARM CAPITAL INVESTMENT

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ABSTRACT

Business risk management (BRM) programs can help reduce the risk inherent in the agricultural industry that is associated with income variability. These programs are commonly in the form of insurance (production insurance, net margin insurance, etc.). There is a vast literature on investment decision under risk and uncertainty, but there exists a gap in the empirical analysis of the effects risk-reducing Canadian BRM programs have on investment. This paper examines the relationship between Canadian BRM programs and on-farm capital investment. This is done using theory and empirical analysis motivated by the risk-balancing framework put forward by Gabriel and Baker (1980). Previous papers have researched BRM programs using the risk-balancing approach, but do not look at investment separately from other factors that influence the level of financial risk (Uzea et al. 2014; de Mey et al. 2014). Analysis of repeated cross-sectional data from the Farm Financial Survey is conducted. Results show that there exists a significant and positive correlation between Canadian BRM programs and the decision to invest. Results also show that BRM program participation is positively correlated with higher levels of financial risk. Understanding the effects of BRM programs on investment is essential for designing and directing Canadian agricultural policy with implications for long-term farm productivity.

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AME	Average Marginal Effect
APF	Agricultural Policy Framework
BR	Business Risk
BRM	Business Risk Management
GF	Growing Forward
FR	Financial Risk

1 INTRODUCTION

Business risk management (BRM) programs are important policy tools used to support the Canadian agricultural industry. These programs are designed to mitigate the risk that is inherent in agriculture through forms of yield insurance, margin insurance, and direct payments. While these programs target risk associated with income variability, there have been many studies indicating that there can be indirect effects of adjusting the risk faced by a farm business (e.g., Hennessey, 1998; O'Donoghue and Whitaker, 2010; Sckokai and Moro, 2009; Turvey, 2012). Altering the risk profile of a business can affect operational behaviour and farm-level decisions.

A typical example of this is the moral hazard issue with insurance. Moral hazard occurs when risk is reduced under insurance, and a firm alters their behavior as a result of the reduced risk. In the context of agricultural BRM programs and farm operators, a particular risk is covered under insurance which may incentivize the insured to increase or induce risk in another aspect of their operation. If the adjustment of a risk-related behaviour is made given that it will raise their expected well-being, profit, or another objective, then the adjustment in behaviour can be viewed as optimizing with respect to the operations objective function. This concept has been generalized into a framework called risk balancing (Gabriel and Baker, 1980; Collins, 1985). The general theory states that the optimal level of different sources of risk faced by a firm will adjust with respect to each other. In the context of BRM programs, it is important to consider the distinction between moral hazard and optimization when discussing the context of farm-level behavioural adjustments (Turvey, 2012).

Risk balancing can complicate the primary purpose of BRM programs: risk reduction. The overall risk may not decrease if other risk components are adjusting in a manner that counters the effects of the BRM program. That said, there may be positive adjustments that occur because of or related to BRM program participation. The success or failure of BRM programs can be analyzed by looking further into the factors that influence different types of risk, how the factors and risk levels adjust, and if these outcomes are aligned with the stated policy goals.

This paper explores the relationship between BRM program enrollment and on-farm capital investment behaviour of Canadian farms by examining the role of altering a farm operation's risk on their investment decision. The relationship between BRM programs and financial risk is also examined. The risk balancing framework motivates analysis of these relationships. Previous studies have examined risk balancing behaviour of farms but generally frame this behaviour in negative contexts by commenting on changes in the overall likelihood of default (e.g., Featherstone et al., 1988; Fernandez-Villaverde et al., 2011; Uzea et al., 2014; Vercammen, 2007). The literature on agricultural insurance programs and farm-level decisions is also commonly framed in a negative context such as examining the presence of moral hazard by looking at changes in input and output decisions under insurance (Babcock and Hennessy, 1996; Ramaswami, 1993; Smith and Goodwin, 1996). Viewing investment as a risk-altering component shifts the focus of farm insurance and risk balancing discussions away from negative behavioural adjustments towards potential productivity gains through capital investment.

Evidence of a positive relationship between BRM program participation and investment is found using a representative sample of Canadian farms obtained from the Farm Financial Survey (FFS). A statistically significant positive correlation between the likelihood of investment and BRM program enrolment is found across various policy periods and farm types. A statistically significant positive correlation is found between BRM program enrolment and financial risk across two measures of financial risk as well. The positive correlation between BRM program enrolment and the likelihood of investment indicates that BRM programs may have indirect effects on risk-related farm-level decisions such as investment. A possible interpretation of the results is that BRM programs help operations that choose to invest; or more generally, farms that decide to invest may also decide to enrol in BRM programs. Investment behaviour is an important factor in the growth and productivity of agricultural operations. Evidence of the correlation between investment and BRM programs highlights the importance for policymakers to take into consideration investment behaviour when designing and evaluating agricultural programs.

The remainder of the paper begins with background on Canadian BRM programs and a literature review of risk balancing theory, empirical applications of risk balancing, and investment behaviour in Chapter 2. Chapter 3 provides an explanation of risk balancing theory using models developed by Gabriel and Baker (1980) and Collins (1985) and the theory in the context of BRM programs and investment. The empirical methodology is conducted in Chapter 4, followed by results and discussion in Chapter 5. Chapter 6 concludes the paper with a summary and further research suggestions.

2 BACKGROUND AND LITERATURE

This chapter is separated into three sections. The first section lays out the policy objectives and technical design of the Canadian BRM programs examined in the analysis for this paper. The second section reviews the theoretical interpretations and empirical application of risk balancing theory in the literature. As the literature on risk and financial structure is extensive, papers and empirical studies most relevant to the application in this paper are the focus of this section. The final section summarizes the relevant literature on the effect of risk and risk-related factors on investment behaviour and capital structure. This includes previous empirical literature examining the relationship between investment and BRM programs.

2.1 BRM Programs in Canada

In recent decades, Canada's suite of BRM programs has been relatively stable. Under the Canadian Agricultural Policy Framework (APF) spanning from 2003 to 2007, subsidized production insurance and a form of margin insurance called the Canadian Agriculture Income Stabilization (CAIS) program were a part of Canada's suite of BRM programs. Following APF, the Growing Forward farm bill maintained the subsidized yield and margin insurance under the titles AgriInsurance and AgriStability, respectively. The first Growing Forward spanned from 2008 to 2012. Growing Forward 2 maintained the suite of BRM programs under the same names between 2013 and 2018. The level of coverage and margin reduction required to trigger a payment has varied slightly, but the programs' general designs have remained similar across the different agricultural policy periods. Funding for the BRM programs across the APF and Growing Forward policy periods are split 60:40 between the federal government and the provinces and territories respectively.

2.1.1 Technical Details

The CAIS was a margin-based insurance. A payout occurred when the current year's allowable revenue less expenses was below the operation's five-year Olympic average of that measurement. This historical average is known as the reference margin. While 100% of an operation's reference margin is covered, the level of payout depends on the margin of loss. A loss of 0% to 15% triggered a 50% payout of that marginal loss. A loss of 15% to 30% triggered a 70% payout of that marginal loss. A loss of 30% to 100% triggered an 80% payout of that marginal loss.

A negative margin, or loss greater than 100% of an operation's reference margin, resulted in a 60% payout on the negative margin.

BRM programs for Growing Forward 1 were launched in 2008. The new federal margin insurance, AgriStability, applied the same use of a reference margin as in CAIS. AgriStability provided coverage for 85% of an operation's reference margin, unlike CAIS which covered 100%. In Growing Forward, the upper portion of coverage was replaced by AgriInvest which allowed farmers to place up to 100% of their net allowable sale in an account wherein the government matched 1% of the farmer's contributions, up to $15,000. Under AgriStability, a loss between 15% and 30% triggered a 70% payout of that marginal loss. A loss of 30% to 100% triggered an 80% payout of that marginal loss. A loss of greater than 100% of the reference margin triggered a 60% payout of the negative margin.

Growing Forward 2 was implemented in 2013 and made only minor changes to the previous suite of BRM programs. This iteration of AgriStability covered 70% of an operation's reference margin. AgriInvest remained intact with its intended purpose of covering small marginal declines. Changes were made to how the reference margin was calculated, such as widening the scope of allowable revenue and expenses. A significant change to the program was the use of an operation's allowable expenses as their program reference margin if this value was lower than the traditional reference margin calculation. This decreased coverage for operations with low input costs relative to their reference margin. A loss of 30% to 100% triggered a 70% payout of that marginal loss. A negative margin results in a 60% payout of that marginal loss. Figure (1) gives a visual depiction of the coverage provided by CAIS and AgriStability from Growing Forward 1 and 2.

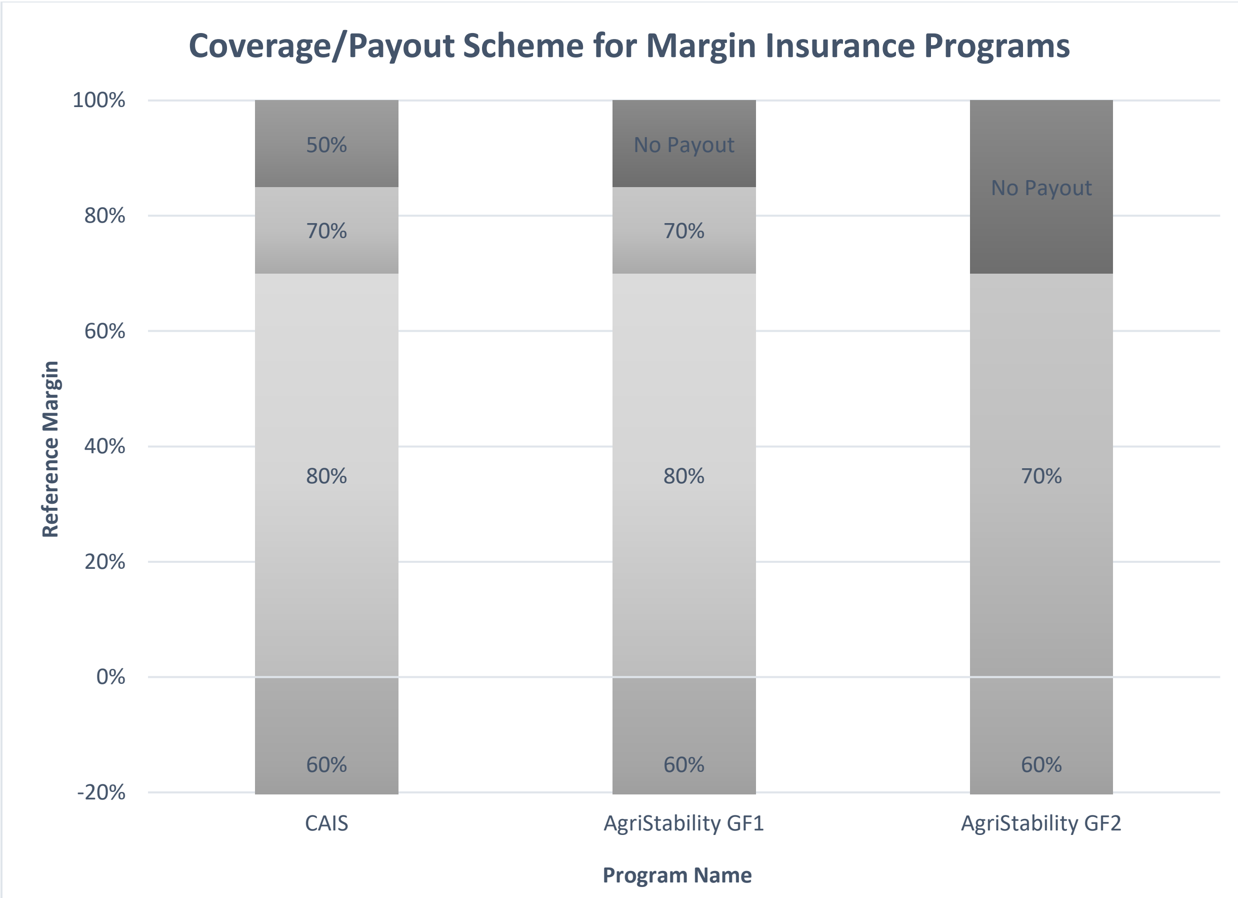

Figure 2.1 Coverage and Payout Scheme for Margin Insurance Programs[1]

Production insurance has remained relatively unchanged through the policy periods. Production insurance insures a specified level of yield, and quality in some cases, for a given season and crop. The level of coverage is a percentage of a producer's average yields determined by their historical yields. The producer is in a position to claim if their actual yield is below the insured yield amount due to an insured peril such as drought, excessive moisture or rainfall, flood, or frost. The payout is calculated by multiplying the difference between actual and insured yield with a price determined in the contract. The base price for crop insurance in Saskatchewan is the forecasted farm gate market price determined in January by the Market Analysis Group at Agriculture and Agri-Food Canada (Saskatchewan Crop Insurance Corporation, 2018).

[1] Percentages inside bars represent the proportion of the margin that is paid out under the program.

The primary objective of covering a specified level of quantity or quality of production is carried throughout APF and Growing Forward 1 and 2. The level of coverage, price options, and other program parameters can vary across provinces and individuals within provinces, even within policy periods. Although the cost of government production insurance is jointly shared between the federal and the provincial and territorial levels of government, the provinces are responsible for administering production insurance.

2.1.2 Policy Goals

There are two types of policy goals to look at when evaluating BRM programs. The first is the policy directives for the overarching agricultural policy framework (i.e., APF and Growing Forward). The second is the policy goals for the individual BRM programs. While each program has a primary purpose, some are suffixed by supplementary goals and general principles that dictate the function and application of the program (Agriculture and Agri-Food Canada, 2005; Agriculture and Agri-Food Canada, 2008).

A 2005 APF federal-provincial-territorial agreement states the objectives of the policy framework as positioning Canada to be a global leader in food safety, innovation, and environmentally-responsible production. Farm-level investment can play an important role in each of these objectives.

The desired strategic outcomes for Growing Forward are laid out in a federal-provincial-territorial agreement as the following: "*a sector that is proactive in managing risk, a sector that contributes to society's priorities, and a competitive and innovative sector*" (Agriculture and Agri-Food Canada, 2008). The first point refers directly to BRM programs and their primary goal of managing risk. The third point can be interpreted as promoting investment by farms which facilitate the adoption of innovative technologies and practices. The third point is reiterated in the agreement in a section stating the general principles of risk management programming. It states that BRM programs "*should contribute to market-oriented adjustments and adoption of technological innovations*" (Agriculture and Agri-Food Canada, 2008).

The general principles of risk management programming also state that "*programs should minimize moral hazard and not influence farmers' production and marketing decisions*" (Agriculture and Agri-Food Canada, 2008). The interpretation of moral hazard likely refers to decisions related to the risk that is covered under the program. For example, if a farmer has yield insurance for canola, but not other crops, he may decide to plant a higher proportion of canola, reducing the diversity of his operation and increasing the risk and probability of payout. Alternatively, if the moral hazard problem is viewed in a whole farm perspective, the adjustment of risky behaviour could occur in another aspect of the farm business not directly related to current canola yields such as investment or financing decisions.

The same document states that "*payments for the purpose of stabilization, disaster mitigation or production loss should not be capitalized into assets*" (Agriculture and Agri-Food Canada, 2008). Capitalization of assets is seen with Common Agricultural Policy payments and land prices in Europe, where direct farm payments caused farmland prices to inflate (Guastella et al., 2018; Kirwan and Roberts, 2016; O'Neill and Hanrahan, 2016). A less direct form of capitalization of program payments may occur through increased productivity. Program payments may influence farmers' behaviour in a way that results in increased productivity. The increased productivity may then be capitalized into farm assets.

Across both APF and Growing Forward policy periods, the primary policy goal for BRM programs was to provide agricultural producers with tools to manage risk and stabilize farm incomes. Income stabilization programs like CAIS and AgriStability targeted whole farm incomes and aimed to provide support for large margin losses. Production insurance under APF and AgriInsurance were designed to stabilize farmers' incomes by minimizing the financial impact of production losses due to natural causes.

2.2 Risk Balancing

The theory of risk balancing was formalized in a paper by Gabriel and Baker (1980). The risk balancing framework is presented as an equation representing the total risk faced by a firm as the combination of financial risk and business risk constrained by the "maximum tolerable total risk." How this tolerable level of total risk is calculated is not explicitly stated in the paper but is assumed to be determined when optimizing profit subject to total risk.

Collins (1985) presents an alternative model that is consistent with the risk balancing framework put forward by Gabriel and Baker (1980). Collins suggests a structural model of the debt-equity decision faced by a firm. Maximizing the equation provides us with relationships between different components of risk that are found in Gabriel and Baker's model.

Featherstone et al. (1988) develop a theoretical framework of risk balancing by constructing a mean-variance model to determine the optimal leverage for a firm. Comparative statistic analysis carried out on the model provides results consistent with the previous risk balancing literature. Featherstone et al. (1988) find that policies aimed at reducing the variability of return on assets, or business risk, increase the variance of return on equity through increased leverage, or financial risk. They find that business risk-reducing policies increase the probability of a firm losing all or part of their equity capital and going bankrupt due to the increase in optimal leverage.

The common approach to empirical risk balancing analysis is through correlation analysis and regression analysis with panel data to estimate adjustments in risk measures across time. Several empirical papers approach risk balancing directly by examining business risk and financial risk explicitly, while others provide evidence of risk balancing though specific farm-level behavioural adjustments. Escalante and Barry (2003) approach risk balancing directly by conducting correlation analysis on business and financial risk measures for a sample panel of Illinois grain farmers. They find that risk balancing is most evident when using a business risk measure that only accounts for the previous two years. De Mey et al. (2014) and Uzea et al. (2014) apply correlation and regression analysis on a panel of farms from the EU-15 and Ontario, Canada, respectively. De Mey et al. (2014) find evidence of risk balancing through both methods with regression results showing that financial risk adjusts following a change in business risk. Uzea et al. (2014) find just over half their sample displays risk balancing behaviour, but their regressions results find no evidence of year-over-year financial risk adjustment.

Of the papers that touch on risk balancing implicitly, there are several that examine how risk-related agricultural programs and policies affect risk-related farm behaviour. Coble et al. (2000) examine how crop and revenue insurance affect the level of hedging for US corn producers, where hedging can be seen as an alternative risk management tool. They find that crop insurance is complementary to hedging while pure revenue insurance has a strong substitution effect and therefore reduces the demand for hedging. Turvey (2012) looks at the optimal crop choice faced by a representative sample of Manitoba producers under whole farm revenue insurance. Using simulated data, Turvey (2012) finds that whole farm income insurance with subsidised premiums can affect producers' choice of crops. Uzea et al. (2014) and Ifft et al. (2015) look at the effect of insurance on the different measures of financial risk. Uzea et al. (2014) find enrolment in federal margin insurance programs to be correlated with an increase in financial risk, measured by interest expenses over total operating revenue, for crop and beef producers. Ifft et al. (2015) use propensity score matching on a representative sample of US farms to estimate the difference in debt levels for operations that participate in federal crop insurance programs and those that do not. They find federal crop insurance program participation to be correlated with short-term farm debt, but not long-term farm debt. These empirical studies allude to risk balancing behaviour as they find that participation in risk-reducing programs like insurance may lead to adjustments in risk-related farm behaviour such as the use of risk-reducing tools or the decision to take on more debt.

2.3 Investment Decision and Risk

Investment under uncertainty is a well-researched topic with many studies examining the adverse effects of uncertainty on investment behaviour (e.g., Baum et al., 2010; Bloom et al. 2007; Boyle and Guthrie, 2003; Doshi et al., 2017; Fernandez-Villaverde et al., 2011). While there is a vast literature on investment and uncertainty, the focus of this section is to review literature that is relevant to the agricultural industry. Empirical studies of farm investment behaviour are reviewed to guide the methodology and motivate the risk balancing relationship between BRM program enrolment and investment.

Uncertainty can stem from policy, interest rates, rate of return, and cash flow, all of which can affect investment. The effect of uncertainty on investment behaviour can be ambiguous if the source of uncertainty is not specified (e.g., Baum et al., 2010; Boyle and Guthrie, 2003). Baum et al. (2010) look at the US manufacturing sector and examine the linkages between uncertainty derived from a firm's stock return, overall market uncertainty, and capital investment behaviour. Their results show that uncertainty or volatility in the market has a direct negative effect on fixed capital investment spending. They also find that uncertainty derived from a firm's own returns effects investment through cash flow, while the sign of the effect may vary. Caballero and Pindyck (1996) use the firm-level US to find higher industry-wide uncertainty, defined by the variance of the marginal revenue product of capital, raises the required rate of return on capital for an investment to occur. Ghosal and Loungani (2000) use industry-level data to find that uncertainty of profits for US firms decreases expenditure on investment, with the negative effect on investment more substantial for industries consisting of smaller firms.

There are several recent empirical studies examining investment behaviour and income stabilizing agriculture programs. Heikkinen and Pietol (2009) model optimal investment behaviour and cost of uncertainty using a dynamic stochastic programming model. They find that uncertainty costs are dependant on future income variability, therefore affecting the decision to invest, as well as timing. In some cases, greater future income variability is found to increase an option value of postponing an investment. Their analysis is motivated by cases of policy uncertainty causing the rate of return of investment to be uncertain for Finnish farmers.

Sckokai and Moro (2009) apply a dynamic dual model of choice under uncertainty, allowing for farmers' risk attitudes, to evaluate the effect of Common Agricultural Policy (CAP) BRM programs on farm investment behaviour. A dataset of Italian crop farmers is used to parameterise a normalised quadratic multi-period expected utility function. The resulting investment demand equation and supply equations are then used to simulate the effect of different policies on the demand for investment. They find that farm investment is positively affected by price intervention policies due to reduced price volatility. Policies unrelated to output price uncertainty have a smaller effect on investment behaviour. Their results show that uncertainty surrounding expected profit, and thus policies that effect uncertainty, can affect investment behaviour.

Kallas et al. (2012) use a reduced-form application of the model by Sckokai and Moro (2009) to evaluate the effect of CAP direct payment programs based on historical yields on investment behaviour. The model is applied to a dataset of cereal, oilseed, and protein producers in Spain. They find evidence that program payments affect investment decision positively for buildings, land improvements, machinery, and equipment. Their analysis also finds crop insurance contracts increase investment through its reduction in revenue uncertainty.

Investment can be affected by financial constraints or credit accessibility which, in turn, can be closely linked to risk faced by agricultural operations. Minton and Schrand (1999) find cash flow volatility to increase the cost and likelihood of accessing capital markets for US firms using firm-level data. Their results suggest that firms forgo investment rather than access external capital markets to cover cash flow deficits. Hughes et al. (1984) estimate the effect of federal credit subsidies on the financial structure and investment behaviour of US farms. Simulations are conducted using a baseline model which is estimated using 1976 to 1980 data. They find a small decrease in farm debt in the short-term and a larger decrease in the long-term with a marginal reduction in farm credit subsidies. Hughes et al. also find that the absence of federal credit subsidies translates to farmers holding fewer financial assets and owing less debt as a result. In other words, greater access to credit may result in more financial assets, but higher debt. Empirical studies have found agricultural investment to be affected by financial constraints by looking at the sensitivity of investment to cash-flow as a measure of financial constraints (e.g., Benjamin and Phimister, 2002; Bierlen and Featherstone, 1998; Chaddad et al., 2005). O'Toole et al. (2014) find similar results in the context of the Irish financial crisis using a measure of internal financial dependence versus external financing as a determinant of financial constraints due to criticisms of the cash-flow measure. These results imply that credit accessibility can influence investment and the level of financial risk of an agricultural operation.

3 THEORETICAL MODEL

3.1 Risk Balancing Model

This paper will rely on the theoretical models presented by Gabriel and Baker (1980) and Collins (1985). Gabriel and Baker (1980) provide a simple understanding of risk balancing behaviour using a risk constraint, while Collins (1985) represents risk balancing in a structural equation of the debt-equity decision made by the farm business to maximize the expected utility of wealth. Both approaches yield results that are consistent with the hypothesized positive relationship between BRM program enrolment and investment but provide different interpretations of risk measures.

The total risk a business faces can be separated into the two distinct components of business risk (BR) and financial risk (FR). Gabriel and Baker (1980) define BR as the inherent risk in the farms operating performance, independent of how it is financed. The risk associated with weather or commodity prices are typical examples of BR in agriculture. FR is defined as the added risk associated with how an operation finances its debt. Interest rate risk, credit risk, and other risks associated with leverage fall under FR. For example, if an operation's fixed debt obligations increase due to movements in interest rates, FR has increased.

The model below, put forward by Gabriel and Baker (1980), is an equation capturing a firm's BR and FR to which a risk constraint, β, is applied. The risk constraint is assumed to be optimal for the specific operation. This relies on the assumption that a firm is maximizing their objective function subject to the total risk constraint rather than the components separately (Gabriel and Baker, 1980).

$$\underbrace{\frac{\sigma_{NOI}}{E[NOI]}}_{\text{BR}} + \underbrace{\left(\frac{\sigma_{NOI}}{E[NOI]} * \frac{I}{(E[NOI] - I)}\right)}_{\text{FR}} \leq \beta \tag{3.1}$$

$E[NOI]$ is the firm's expected net operating income while σ_{NOI} represents the variability of net operating income. Both are independent of the way the firm is financed. I represents fixed debt obligations or payments. The first term in Equation (3.1) represents BR and is independent of FR. BR becomes greater as the variability of net operating income increases and decreases as expected net operating income increases. The second term in brackets represents FR, defined as the interaction between $\frac{I}{(E[NOI]-I)}$ and $\frac{\sigma_{NOI}}{E[NOI]}$. FR can be interpreted as the added risk to an operation's net operating income due to fixed debt obligations. As fixed debt obligations increase, so does FR. In this model, it is not clear whether fixed debt obligations increase due to higher debt or interest rates. FR also increases with increased BR.

The risk balancing behaviour occurs through the strategic adjustment of FR and BR components to maintain the optimal level of total risk or β. Consider the case of an exogenous reduction in σ_{NOI} due to policy. A decrease in σ_{NOI} reduces the first BR term as well as decreasing the FR term through a reduction in BR. There is now slack in the risk constraint, allowing adjustments in FR or BR through firm-level adjustments to increase total risk back to the optimal level, β.

The risk balancing model by Collins (1985) specifies a structural equation that maximizes an operation's expected utility of the rate of return on equity with respect to their debt-to-asset ratio. The fundamental assumption of Collins' model is that a farm's primary objective is to maximize their expected utility of the rate of return on equity. Collins refers to BR as the variance or rate of return on assets. Like Gabriel and Baker (1980), FR is the added variability to the return on equity stemming from the operation's leverage position. Below is the debt-equity decision,

$$\max_{\delta} EU[ROE] = E[ROE] - \frac{\rho}{2}\sigma_{ROE}^2 \tag{3.2}$$

where $E[ROE]$ is the expected rate of return on equity, ρ is a risk aversion parameter, and σ_{ROE}^2 is the variance of the rate of return on equity. $E[ROE]$ is assumed to be a function of the expected rate of return on assets ($E[ROA]$), the fixed interest rate on debt (i), and the debt-to-asset ratio (δ) as defined below.

$$ROE = (ROA - i\delta)(1-\delta)^{-1}$$

$$E[ROE] = (E[ROA] - i\delta)(1-\delta)^{-1} \tag{3.3}$$

$$\sigma_{ROE}^2 = \sigma_{ROA}^2(1-\delta)^{-2} \tag{3.4}$$

Collins assumes ROA is a random variable with mean $E[ROA]$ and variance σ^2_{ROA}, giving Equations (3.3) and (3.4) above which can be then substituted into the objective function defined in Equation (3.2).

$$\max_{\delta} EU[ROE] = (E[ROA] - i\delta)(1-\delta)^{-1} - \frac{\rho}{2}\sigma^2_{ROA}(1-\delta)^{-2} \tag{3.5}$$

Solving for the optimal δ or leverage ratio yields us with the following equation.

$$\delta^* = 1 - \frac{\rho\sigma^2_{ROA}}{E[ROA] - i} \tag{3.6}$$

Collins shows that taking the derivative of the optimal leverage ratio with respect to σ^2_{ROA} yields the following equation

$$\frac{\partial\delta^*}{\partial\sigma^2_{ROA}} = -\frac{\rho}{E[ROA] - i} < 0 \tag{3.7}$$

which implies a negative relationship between the debt-to-asset ratio (FR) and the variance of the rate of return on assets (BR), as long as the fixed interest rate on debt is less than the expected return on assets. For example, an exogenous increase in the variance of the rate of return on assets is hypothesized to result in a decrease in an operation's optimal debt-to-asset ratio, causing a downward adjustment. This negative relationship is consistent with the risk balancing framework introduced by Gabriel and Baker (1980).

3.2 BRM Programs and Investment within a Risk Balancing Framework

The risk balancing framework is used to motivate the hypothesized relationship between BRM program enrolment and capital investment behaviour. BRM programs and investment can influence the risk profile of a farm operation and can be represented in the risk balancing framework. Equation (3.1) and Equation (3.5) are used to show how BRM programs and investment can affect BR and FR within a risk balancing context.

Before applying BRM programs and investment to the risk balancing framework, it is important to consider the mechanisms driving the relationship between the two. BRM programs can be linked to an operation's decision to invest in several ways. Two relevant mechanisms to the risk balancing models are the increase in borrowing capacity and altering an operation's ability to finance debt resulting from the investment. Enrolment in BRM programs may signal to potential creditors good business planning and management abilities, and therefore a reduced risk of defaulting on their loan. BRM program enrolment can increase the amount and likelihood of credit available for an operation to make an investment (Hughes et al., 1984; Minton and Schrand, 1999). BRM programs can also increase an operation's ability to finance their debt by reducing the volatility of cash flow, providing an operation with consistent cash flow necessary to finance debt. BRM programs and investment have a positive relationship through both these mechanisms.

Under the model presented by Gabriel and Baker (1980), both program participation and investment can alter components of Equation (3.1). The design of BRM programs is to reduce income volatility faced by farmers. Given this, program participation should reduce σ_{NOI} within the model. This reduces the BR component and part of the FR component, resulting in a reduction of total risk. Investment can increase I within the FR component if investments are made through debt, therefore increasing the fixed debt obligations. By increasing I through investment, FR increases, resulting in an increase of total risk. In Equation (3.1), BRM program participation and investment have opposite effects on the level of total risk. Investment and BRM program participation have a positive relationship within the model presented by Gabriel and Baker (1980).

The model developed by Collins (1985) has a similar result. In Equation (3.5), BRM program participation should reduce the variability of the rate of return on assets (σ^2_{ROA}), while investments made through debt financing will affect the debt-to-asset ratio (δ). Equation (3.7) shows that the optimal δ and σ^2_{ROA} are negatively correlated. Therefore, a decrease in σ^2_{ROA}, or BR, through BRM program enrolment translates to an increase in the optimal δ, or FR.

Risk balancing theory provides a basic model to explicitly show the intuitive, positive relationship between BRM program participation and investment behaviour, while the mechanisms driving the relationship are not made explicit in the models. The uncertainty of the mechanisms is addressed in the discussions section for the BRM program and investment analysis in Chapter 5.

4 EMPIRICAL METHODOLOGY

The empirical analysis is divided into three sections. First, summary statistics for the data are presented. Second, regression analysis is conducted to examine the relationship between BRM program participation and financial risk measures. Third, the relationship between BRM program participation and investment is empirically examined.

The analysis is carried out across pooled samples as well as different sub-samples distinguished by policy period and farm type. Production insurance and margin insurance participation enter the models simultaneously but separately as farms can choose to participate in one, both, or neither of the programs.

The analysis is applied to grain and oilseed producers, cattle operations, and a pooled sample. Each farm type sample, including the pooled sample, is further separated and analyzed by policy period. Grain and oilseed producers and cattle operations are separately examined because they constitute a large proportion of Canada's agricultural industry. It is also likely that different BRM programs will have varying effects on different operation types. For example, crop insurance is tailored for certain types of crop producers while margin insurance such as AgriStability is designed for a wider variety of operations.

4.1 Data

The data used for the two analysis sections is survey data from the Farm Financial Survey (FFS) provided through Agriculture and Agri-Food Canada. The FFS provides financial data on a representative sample of Canadian farms across different types of agricultural operations. The data includes assets, liabilities, revenues, costs, capital sales, capital investments, and farm characteristics for each survey reference year. The reference year is either the fiscal year or calendar year depending on how an operation records its information.

Available data spans from 1999 to 2015 with gaps due to changing frequency of the survey across the period. The period of data used for analysis spans from 2003 to 2015. During this period, the survey was conducted annually from 2003 to 2011, then every two years from 2011 to 2015. Financial data necessary for constructing variables for the BRM program and investment analysis is not collected for survey years 2006, 2008 and 2010. The data can be divided into two policy periods. The first policy period covers the APF from 2003 to 2007 while the second policy periods covers Growing Forward 1 and 2 from 2008 to 2015.

The analysis of the paper focuses on the two primary forms of BRM programs, government subsidized production and margin insurance, from 2003 to 2015. Private insurance alternatives to these BRM programs are available during this period but are not used in the analysis. This is due to the lack of data on private insurance enrolment and the relatively small market share these private options hold. AgriInvest is not examined in the analysis due to its high rate of enrolment in the sample. In other words, there is little variation in participation. With respect to risk management, part of the stated objective of AgriInvest is to help farms manage small income declines by encouraging them to save and receive payment for doing so (Agriculture and Agri-Food Canada, 2018). The amount of direct payment is capped at $15,000 per program year. This is a relatively small amount of relief in the event of a margin decline and would likely not have a large effect on risk related behaviour.

A new representative sample is drawn each survey year resulting in a repeated cross-sectional dataset. There is a roughly 30 percent overlap of survey respondents year over year, but they cannot be tracked across more than two survey years. The survey sample pulls farms from the Business Register to obtain a list of all farms in Canada. These farms are placed into a stratum based on province, size, and type of operation. The size of each stratum is determined by the revenue and assets of the farms. Simple random sample takes place at the stratum level. Sampling weights are applied to each farm in the sample based on the probability of selection. These weights are used for obtaining summary statistics of the sample and estimating models in the analysis section. Since this is a representative sample of Canadian farms, the composition of farms in the sample reflect the composition of the farm population.

In 2013, farms with less than $25,000 in farm revenue were excluded from the sampling population. Farm operations in previous sample years with less than $25,000 are dropped to maintain a consistent sample group across survey years.

4.1.1 Descriptive Statistics

Table (4.1) provides descriptive statistics of the pooled sample used in the BRM program and investment analysis for the variables defined above. Descriptive statistics are given for each policy period. The descriptive statistics apply to the total population of Canadian agricultural operations with the use of probability weights. The mean and standard deviation for each variable is estimated. The descriptive statistics of the analysis sample reflect statistics for the Canadian agriculture industry released by Statistics Canada across the sample years.[1] This indicates that our sample is representative of Canadian farms.

Table (4.2) provides the weighted means of the investment variables and BRM program enrolment for grain and oilseed producers and cattle operations by policy periods. BRM program enrolment rates for the APF consistent with program assessment reports published by AAFC, while enrolment rates during the Growing Forward policy period are slightly lower than figures released by AAFC for both farm types. The general reduction in enrolment between policy periods is consistent with the published rates.

While investment rates between policy periods for grain and oilseed producers are relatively unchanged, there are notable differences between policy periods for cattle operations. The proportion of cattle operations making an investment based on the FFS variable decreases by roughly 18 percentage points from APF to Growing Forward. There is also a decrease of about 10 percentage points for the net capital investment variable, 3 percentage points for the net machine investment variables, and 4.5 percentage points for the machine purchase variable.

4.2 BRM Program Participation and Financial Risk

Before analyzing the relationship between BRM programs and investment, the question of whether BRM program participation is correlated with higher FR is examined. While the relationship between BRM program participation and FR is motivated by risk balancing theory, it cannot directly represent a risk balancing relationship because BRM program participation may not necessarily translate to lower BR. The hypothesized positive relationship between BRM program participation and FR provides important context for understanding the BRM program participation and investment relationship. Two measures of FR requiring separate empirical approaches are used in the analysis. The use of two FR measures is applied for robustness.

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[1] Farms classified by farm type, historical data. Table: 32-10-0166-01. Statistics Canada
Farms classified by size, historical data. Table: 32-10-0156-01. Statistics Canada
Farms classified by total gross farm receipts, 2015 constant dollars, historical data. Table: 32-10-0157. Statistics Canada

Table 4.1: Summary Statistics of Analysis Sample by Program Periods

Variable	APF Mean (Standard Deviation)	Growing Forward Mean (Standard Deviation)	Pooled Policy Period Mean (Standard Deviation)
Binary Investment Variables			
FFS Investment Variable	0.587	0.569	0.579
Net Capital Investment	0.550	0.543	0.547
Net Machine Investment	0.471	0.448	0.461
Machine Purchase	0.462	0.435	0.450
BRM Program Participation			
Margin Insurance	0.558	0.415	0.493
Production Insurance	0.602	0.455	0.535
Covariates			
Profit Margin	0.090 (0.721)	0.110 (0.580)	0.099 (6.657)
Debt-to-TGR	1.251 (2.714)	1.306 (3.041)	1.276 (2.909)
Diversification Index	0.802 (0.339)	0.817 (0.280)	0.809 (0.313)
Liquidity	0.368 (1.278)	0.456 (1.662)	0.408 (1.502)
Yrs of Experience	28.967 (23.050)	31.561 (19.921)	30.146 (21.734)
Proportion of Sample by Province/Region			
Atlantic Canada	0.027	0.026	0.026
Quebec	0.153	0.157	0.155
Ontario	0.218	0.234	0.225
Manitoba	0.096	0.091	0.094
Saskatchewan	0.253	0.241	0.248
Alberta	0.211	0.209	0.210
British Columbia	0.041	0.042	0.042

Proportion of Sample by Revenue Class			
$25,000 to $99,999	0.397	0.312	0.358
$100,000 to $249,999	0.293	0.247	0.272
$250,000 to $999,999	0.266	0.338	0.298
$1,000,000 and over	0.044	0.103	0.071
Proportion of Sample by Farm Type[a]			
Grain & Oilseed	0.422	0.496	0.456
Horticulture	0.075	0.084	0.079
Dairy	0.130	0.117	0.124
Cattle	0.307	0.252	0.282
Hog	0.039	0.024	0.032
Poultry	0.027	0.028	0.027
Sample Size	39035	25479	64514

[a] Remaining farms are coded as “Other” in the dataset.

Table 4.2: Summary Statistics of Farm Type Samples

Variable	APF	Growing Forward	Pooled Policy Period
	Mean	Mean	Mean
		Grain & Oilseeds	
Binary Investment Variables			
FFS Investment Variable	0.570	0.571	0.571
Net Capital Investment	0.539	0.552	0.545
Net Machine Investment	0.490	0.485	0.488
Machine Purchase	0.482	0.472	0.477
BRM Program Participation			
Margin Insurance	0.658	0.469	0.565
Production Insurance	0.846	0.600	0.725
Sample Size	8601	8122	16723
		Cattle	
Binary Investment Variables			
FFS Investment Variable	0.539	0.521	0.531
Net Capital Investment	0.487	0.476	0.483
Net Machine Investment	0.406	0.374	0.393
Machine Purchase	0.400	0.365	0.386
BRM Program Participation			
Margin Insurance	0.551	0.380	0.482
Production Insurance	0.394	0.294	0.354
Sample Size	11910	5041	16951

The first approach uses $\frac{I}{(NOI-I)}$, the percentage of fixed interest payments over net-operation-income, as a measure of FR. This measure is consistent with the model by Gabriel and Baker (1980) and is used in previous empirical risk balancing analysis (De Mey et al., 2014; Uzea et al., 2014). To reiterate, I is the operation's fixed interest payments or fixed debt obligations in the model. $(NOI - I)$ is the operation's net operating income less fixed interest payments. By dividing the fixed interest payments by net-operating-income, the FR measure becomes a risk index that can be compared across farm sizes. A greater I or lower NOI results in a higher FR level. This measure of FR results in farms being dropped from the sample due to zero and negative net-operating-income values. The implications of the dropped observations on our results are touched on in the shortcomings section for the BRM program and FR analysis in Chapter 5. Many farms do not have any fixed interest payments resulting in a clustering around zero.

Using the fixed interest payments measure of FR, a tobit model is applied due to the large number of FR values, the dependent variable, equal to zero. A tobit models the effect of the explanatory variables on the dependent variable at the extensive and intensive margin separately. In this case, the extensive margin is whether an operation has a zero value of FR or a value greater than zero, while the intensive margin looks at the change in the amount of FR. The tobit model estimates the effect of BRM program enrolment on both these margins.

The tobit model is defined by the following two assumptions.

$$y = \max(0, X\beta + u) \tag{4.1}$$

$$u|X \sim N(0, \sigma^2) \tag{4.2}$$

Equation (4.1) states that the dependent variable y, or FR, is a maximum of zero or a positive value defined by $X\beta + u$, where X are explanatory covariates, β is a vector of coefficients, and u is the unobserved error term. The zero-value corner solution reflects the distribution of FR using fixed interest payments over net-operation-income in the data. Equation (4.2) states that the distribution of the error term in Equation (4.1) is normally distributed with mean zero and some variance.

The density function of a tobit is defined in Equation (4.3) below. The first and second term on the righthand side of the equation represent the density of the intensive and extensive margin respectively. The exponent of each term is an indicator function that is equal to 1 when the statement inside the square brackets is true, thus separating the density of FR by zero and non-zero values. Θ is the normal cumulative distribution function, while θ is the normal probability density function.

$$f(FR|X) = \left\{\Theta\left[\frac{X\beta}{\sigma}\right]\sigma^{-1}\frac{\theta\left[\frac{FR - X\beta}{\sigma}\right]}{\Theta\left[\frac{X\beta}{\sigma}\right]}\right\}^{1[FR>0]} * \left\{1 - \Theta\left[\frac{X\beta}{\sigma}\right]\right\}^{1[FR=0]} \qquad (4.3a)$$

The density of the tobit is represented in Equation (4.3a). The binary component of the tobit model is made up of $\Theta\left[\frac{X\beta}{\sigma}\right]$ in the first term, representing the probability of a non-zero value of FR, and the entire second term, $1 - \Theta\left[\frac{X\beta}{\sigma}\right]$, representing the probability of FR equal to zero. These address the extensive margin. The uncensored linear section of the tobit is modeled by $\sigma^{-1}\frac{\theta\left[\frac{FR-X\beta}{\sigma}\right]}{\Theta\left[\frac{X\beta}{\sigma}\right]}$, representing the probability density of FR greater than zero. This addresses the intensive margin.

Equation (4.3a) simplifies to Equation (4.3b).

$$f(FR|X) = \left\{\sigma^{-1}\theta\left[\frac{FR - X\beta}{\sigma}\right]\right\}^{1[FR>0]} * \left\{1 - \Theta\left[\frac{X\beta}{\sigma}\right]\right\}^{1[FR=0]} \qquad (4.3b)$$

A sample log-likelihood expression can be derived from the density function to give us Equation (4.4) below.

$$\ell_i(\beta,\sigma) = 1[FR_i > 0]\left(ln\left\{\theta\left[\frac{FR_i - X_i\beta}{\sigma}\right]\right\} - \frac{ln(\sigma^2)}{2}\right) + 1[FR_i = 0]ln\left\{1 - \Theta\left[\frac{X_i\beta}{\sigma}\right]\right\} \qquad (4.4)$$

This can be rewritten as

$$\ell_i(\beta,\sigma) = 1[FR_i = 0]ln\left\{1 - \Theta\left[\frac{X_i\beta}{\sigma}\right]\right\} - 1[FR_i > 0]\left\{\frac{(FR_i - X_i\beta)^2}{2\sigma^2} + \frac{ln(\sigma^2)}{2}\right\}$$

The complete log-likelihood function is

$$L(\beta) = \sum_{i=1}^{n}\ell_i(\beta,\sigma)$$

with n being the number of observations in the population. Using maximum likelihood estimation, values of β and σ that maximize the equation above provide our estimates. Estimators for β and σ are obtained through first order conditions.

FR is the dependent variable, while the two BRM program participation variables are the covariates of interest. Other variables included are debt-to-total gross revenue, profit margin, an income diversity index, a liquidity measure, and manager's years of experience. These variables are included to control for other factors that may be correlated with an operation's level of FR and BRM program enrolment decision. Dummy variables are included for revenue size class, province, farm type, and survey year to account for fixed effects. Farm types are organized into six groups: grain and oilseeds, horticulture (combination of potato, vegetable, fruit, greenhouse, and nursery operations), dairy, beef cattle, hog operations, and poultry and egg.

The tobit model provides three marginal effect estimates: the average marginal effect of BRM program participation on the likelihood of a non-zero FR value, the average marginal effect of BRM program participation on the level of FR given a non-zero FR value, and the average marginal effect of BRM program participation on the level of FR across the entire sample. The marginal effect is the effect of BRM program enrolment relative to nonenrolment on the level or probability of an outcome. This is calculated for each farm operation in our sample using the estimated parameters from the model. Taking the average across the sample gives the average marginal effect. This is an average of all the individual marginal effects.

One of the assumptions of the tobit model is that the mechanism at the extensive and intensive margin move in the same direction. That is, the marginal effect of BRM program participation on the likelihood of a non-zero FR level and its marginal effect on the level of FR given non-zero FR are not independent and therefore must have the same sign. This restriction of the tobit is clear by looking at Equation (4.3a). Both the intensive and extensive margin are determined by $X\beta$ and σ. This is an appropriate assumption since risk balancing motivates the mechanism driving the relationship to obtain both marginal effects.

The second approach uses the debt-to-asset ratio of an operation as a FR measure. The debt-to-asset ratio is a common indicator of a firm's financial state and is consistent with the risk balancing model by Collins (1985), but it does not directly translate to the framework introduced by Gabriel and Baker (1980). The debt-to-asset ratio allows comparison across different farm sizes.

OLS is used to estimate the linear model defined by Equation (4.5) with the FR measure as the dependent variable and BRM program participation as the covariates of interest. The other variables included in the model, X_i in the Equation (4.5), are the same as those included in the tobit model using the fixed interest payments measure of FR.

$$\frac{debt}{asset_i} = \beta_0 + \beta_1 MarginInsurance_i + \beta_2 CropInsurance_i + X_i\beta + e \tag{4.5}$$

The same general hypothesis applies to both approaches: BRM program participation is correlated with higher levels of FR, ceteris paribus. Under the tobit model approach, the hypothesis is extended to state that BRM program participation is correlated with an increase in the likelihood of a non-zero value of FR.

4.3 BRM Program Participation and Investment Analysis

The relationship between BRM program participation and investment behaviour is explored by looking at BRM program participation and the likelihood of investment occurring. The risk balancing framework, paired with previous literature, provides a foundation for the intuitive, positive relationship between BRM programs and investment. The hypothesis of a positive relationship is tested by modeling the change in the probability of investment with respect to BRM program participation. Given the nature of the data, the decision to participate in a BRM program and the decision to invest occur within the same survey reference period.

A logit model is applied to the data with the binary investment decision variable, $Invest$, as the dependent variable. The model below states that the probability an investment occurring is defined by the statement on the right-hand side of the equation. BRM program participation is the variable of interest on the left-hand side and enters the equation as margin insurance and production insurance enrolment separately. Other variables included are profit margin ($Profitm$), debt-to-total gross revenue ratio ($\frac{debt}{TGR}$), an income diversity index ($Divindx$), liquidity (Liq), and manager's years of experience ($Mngexp$). These variables are included to account for other variables that may influence a farm's BR, and factors that could affect an operation's decision to invest. Dummies for province, revenue size class, farm type, and survey year are included in the model to account for fixed effects.

$$P(Invest_i = 1|X) = \Phi(\beta_0 + \beta_1 MarginInsurance_i + \beta_2 CropInsurance_i$$
$$+\beta_3 Profitm_i + \beta_4 \frac{debt}{TGR}_i + \beta_5 Divindx_i$$
$$+\beta_6 Liq_i + \beta_7 Mngexp_i + \sum_{k=1}^{K-1} \beta_k Prov_k \tag{4.6}$$
$$+\sum_{l=1}^{L-1} \beta_l Rev_l + \sum_{m=1}^{M-1} \beta_m Farmtype_m$$
$$+\sum_{t=1}^{T-1} \beta_t Year_t)$$

The profit margin variable ($Profitm$) is calculated as an operation's net operating income divided by their total gross revenue. A higher operating profit margin, if sustained, effectively enters Gabriel and Baker's risk balancing model negatively through in BR and increases the ability of an operation to finance its debt. Through this mechanism, it is expected that $Profitm$ would be positively correlated with the likelihood of an investment being made.

Debt-to-total gross revenue ($\frac{debt}{TGR}$) is calculated by dividing a farm's total debt, long term and short term, by their total gross revenue. The provides a measure of debt that can be compared across farm sizes. $\frac{debt}{TGR}$ is predicted to be negatively correlated with the likelihood of investment.

The diversity index variable ($Divindx$) is a Herfindahl index that represents the diversity of an operation's on-farm income sources. Greater income diversity can reduce income volatility of an operation, reducing BR. Reduced income volatility may allow an operation to finance their debt consistently and is expected to be correlated with an increase in the likelihood of investing.

The liquidity measure (Liq) is calculated by dividing a farm's working capital by total gross revenue. Working capital is an operation's current assets over current debt. Liquidity can be an alternative risk management tool in the context of BR reduction. Liquid assets can be used to reduce income volatility, consequently allowing an increase in FR. Therefore, a larger liquidity measure with respect to total gross revenue is expected to be positively correlated with an increased likelihood of investment.

Years of management of a farm operation ($Mngexp$) is used to capture the effect that farming experience may have the likelihood of investment. More years of experience may be correlated with lower credit constraints compared with farmers with less experience. More experience could also be correlated with higher levels of capital accumulation, placing these farmers in a better position to invest. On the other hand, more years of experience managing a farm may be correlated with greater risk aversion or an aversion to progressive farming techniques requiring capital investment. Years of management experience is expected to be negatively correlated with the likelihood of investment.

Variables for province, revenue class, farm type, and year enter the model as categorical variables. Revenue class (Rev) is included to capture large-scale effects related to the size of operations. They are categorized into the following four total gross revenue ranges: $25,000 to $99,999, $100,000 to $249,999, $250,000 to $999,999, and $1,000,000 and over. The $Farmtype$ variables capture fixed effects related to specific farm operations. The farm type categories are grains and oilseeds, potato, vegetable, fruit, greenhouse and nursery, dairy operations, beef cattle, hogs, eggs and poultry. Finally, year dummies are included to capture year-specific effects that may have influenced investment behaviour across the sample, capturing variables such as interest rates, weather, and macroeconomic fluctuations.

The logit models the probability that an operation will invest or not invest. The binary response model is defined by the expressions below.

$$Invest = \begin{cases} 1 \; if \; y^* > 0 \\ 0 \; if \; y^* \leq 0 \end{cases}$$

$$y^* = x\beta + e \tag{4.7}$$

$$P(Invest = 1|X) = P(y^* > 0|X) \tag{4.8}$$

$Invest$ takes on the value of 1 or 0, invest or not invest. Equation (4.8) is the latent variable model which models the probability of a binary response. Investment occurs when y^* is greater than zero and vice versa. While y^* is not observed, it is assumed to have an expected value of $X\beta$, which includes the covariates explained above, and an error term, e.

The logit is derived below from Equation (4.7) and Equation (4.8). This is a generalized version of Equation (4.6) above.

$$P(Invest_i = 1|X) = \Phi(X\beta)$$

where the probability of an investment occurring is defined by a logistic cumulative distribution function, Φ, and an index defined by $X\beta$. The use of a logistic cumulative distribution function requires the assumption that the error term from the latent variable model, Equation (4.7) has a logistic distribution.

From the density of investment in Equation (4.9)

$$f(Invest_i|X) = [\Phi(x_i\beta)]^{Invest_i}[1-\Phi(x_i\beta)]^{(1-Invest_i)} \tag{4.9}$$

we can write a sample log-likelihood function

$$\ell_i(\beta) = Invest_i ln[\Phi(x_i\beta)] + (1-Invest_i) ln[1-\Phi(x_i\beta)]$$

and then the complete log-likelihood function with n being the number of observations in the population.

$$L(\beta) = \sum_{i=1}^{n} \ell_i(\beta) \tag{4.10}$$

Using maximum likelihood estimation, we get estimates of β that maximize log-likelihood function defined by Equation (4.10).

The estimates of β provide us with the marginal effects of BRM program participation on the likelihood of an investment being made. This model is applied to different sample groups to account for the possibility of varying effects across farm types and policy periods.

It is hypothesized that BRM program participation is positively correlated with the decision to invest within the same survey year. A causal relationship cannot be convincingly drawn due to the potential endogeneity between the decision to invest and the decision to participate.

4.3.1 Capital Investment Variables

The investment variable chosen for the majority model specifications is the binary investment variable pulled directly from the FFS.[1] The survey question asks the respondent whether they had made an on-farm capital invest during the survey period. The variable is equal to 1 when respondents answer 'yes,' and 0 for 'no.' Alternative binary investment variables are

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[1] The question is worded "In [reference year], did this operation invest in any money in capital items or improvements?" (FFS, 2016)

created using the capital investments and capital sales data from the survey and are as follows: *net capital investment, net machine investment, machine purchase*.

The net capital investment binary variable is based on an operation's capital investments less their capital sales. When net capital investment is positive, the variable is equal to 1. When net capital investment is 0 or negative, the variable is set to 0. Net machine investment is similarly constructed, but only includes machinery related investments and sales. When machine purchases less machine sales is greater than 0, the variable is equal to 1 and set to 0 otherwise. The machine purchase variable is simply equal to 1 when machinery is purchased and 0 when it is not.

The model is run on a pooled sample using these alternative investment variables as well as the primary FFS investment variable to compare and analyze the relationship across different forms of capital investment. Running the model using different investment variables is primarily a robustness test. Differences in results between the different investment variables may also highlight specific types of capital that are more sensitive to changes in BR or, specifically, enrolment in BRM programs. These differences may relate to how specific types of capital are financed since only investments financed through debt affect FR and are therefore relevant to the risk balancing framework.

5 RESULTS AND DISCUSSION

This section presents the results from the empirical analysis and discusses the policy implications and interpretations as well as shortcomings of the analysis. Results and discussions are first presented for the BRM program and FR analysis, followed by the BRM program participation and investment analysis.

5.1 BRM Programs and Financial Risk Analysis

Results show that BRM program participation is positively correlated with higher levels of FR. The positive correlation is consistent across all sample groups and periods, but there is a slight variation in significance.

Table (5.1) displays the results for the tobit model using the measure of FR defined by fixed interest payments over NOI. Three average marginal effect estimates are provided for production insurance and margin insurance for each analysis sample. The estimated mean of FR and the estimated mean of FR *given FR is greater than zero* is also given for the pooled period analysis sample to provide context to the average marginal effect estimates. Table (5.2) provides the regression results for BRM programs and financial risk analysis using the debt-to-asset ratio using the same sample groups.

5.1.1 Interest Payments over NOI

The tobit model yields three different average marginal effect estimates for the two BRM programs analyzed for each sample. The three marginal effects are the average marginal effect of BRM program participation on the absolute level of FR and the level of FR given FR is greater than zero, and the average marginal effect of BRM program participation on the probability of a non-zero FR value. The marginal effect on the level of FR should be interpreted as a percentage point change of FR since this measure of FR is the percentage of fixed debt obligation over net operating income.

The first three columns in Table (5.1) are the results for the pooled farm type sample. Margin and production insurance are correlated with a positive average marginal effect for all three marginal effect measures across the three policy period sample groups. Under the pooled policy period sample, margin insurance enrolment is correlated with a 10.7 percentage point increase on

Table 5.1: Results for Tobit Model using Fixed Debt Obligations FR Measure[a]

Variable		All Farm Types APF	All Farm Types Growing Forward	All Farm Types Pooled	Grains & Oilseeds APF	Grains & Oilseeds Growing Forward	Grains & Oilseeds Pooled	Cattle APF	Cattle Growing Forward	Cattle Pooled
Margin Insurance	AME	0.169*** (0.029)	0.065*** (0.021)	0.107*** (0.017)	0.160*** (0.042)	0.056* (0.030)	0.090*** (0.026)	0.275*** (0.053)	0.119*** (0.032)	0.194*** (0.031)
	AME | non-zero FR	0.129*** (0.022)	0.050*** (0.016)	0.082*** (0.013)	0.124*** (0.033)	0.044* (0.024)	0.070*** (0.021)	0.215*** (0.042)	0.093*** (0.025)	0.151*** (0.024)
	AME on the probability of non-zero FR	0.039*** (0.006)	0.024*** (0.006)	0.030*** (0.004)	0.048*** (0.011)	0.020** (0.008)	0.030*** (0.007)	0.067*** (0.011)	0.051*** (0.013)	0.057*** (0.008)
Production Insurance	AME	0.093*** (0.029)	0.064*** (0.022)	0.082*** (0.017)	0.095* (0.049)	0.093** (0.041)	0.099*** (0.032)	0.094** (0.045)	0.085** (0.033)	0.104*** (0.030)
	AME | non-zero FR	0.071*** (0.022)	0.049*** (0.017)	0.063*** (0.013)	0.073* (0.038)	0.073** (0.033)	0.077*** (0.025)	0.073** (0.035)	0.066** (0.026)	0.081*** (0.023)
	AME on the probability of non-zero FR	0.021*** (0.010)	0.023*** (0.006)	0.023*** (0.004)	0.028** (0.014)	0.033*** (0.009)	0.033*** (0.008)	0.023** (0.011)	0.036*** (0.014)	0.032*** (0.008)
Mean FR		0.590 (0.020)	0.410 (0.016)	0.496 (0.013)						
Mean FR | non-zero FR		0.804 (0.027)	0.578 (0.022)	0.688 (0.017)						
Sample Size		34415	29083	63498	7486	9169	16655	8551	4805	13356

***, **, * statistical significance at 1%, 5%, and 10% levels respectively

[a] Covariates: debt-to-total gross revenue, profit margin, income diversity index, a liquidity measure, years of experience, revenue size class, province, farm type, survey year

<u>Table 5.2: Results for Linear Regression Model using Debt-to-Asset Ratio FR Measure</u>

	All Farm Types			Grains & Oilseeds			Cattle		
Variable	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled
Margin Insurance	0.024*** (0.004)	0.016*** (0.005)	0.022*** (0.003)	0.005 (0.006)	0.014 (0.010)	0.014** (0.006)	0.011** (0.006)	0.007 (0.005)	0.010*** (0.004)
Crop Insurance	-0.003 (0.004)	-0.002 (0.005)	-0.002 (0.003)	0.029*** (0.005)	0.020*** (0.006)	0.023*** (0.004)	0.004 (0.006)	-0.006 (0.005)	0.002 (0.004)
R^2	0.155	0.158	0.153	0.478	0.131	0.204	0.351	0.436	0.376
Sample Size	46884	39067	85951	10152	12080	22232	14114	7831	21945

***, **, * statistical significance at 1%, 5%, and 10% levels respectively

Note: Dummies controlling for fixed farm type effects are not included in the *All Farm Types* model.

the absolute level of FR, an 8.2 percentage point increase in the level of FR given FR is greater than zero, and a 3 percentage point increase on the probability of an operation having FR at all. Production insurance enrolment is correlated with an 8.2 percentage point increase in the level of FR, a 6.3 percentage point increase in the level of FR given FR is greater than zero, and a 2.8 percentage point increase in the probability of a non-zero FR level.

The average absolute level of FR for the sample is 0.496 or about 50 percent, while the average FR given FR greater than zero is 0.688 or about 70 percent. With an average marginal effect of margin insurance on the absolute FR level of 10.7 percentage points, margin insurance enrolment translates to a roughly 20 percent change in FR for the average operation in the sample. The average marginal effect of margin insurance enrolment is about a 12 percent change in FR for the average operation with FR greater than zero. Production insurance enrolment translates to about a 16 percent change in FR for the average operation in the sample and a 9 percent change for the average operation with FR greater than zero, respectively.

The average marginal effects for the level of FR are higher for the APF policy period relative to Growing Forward by roughly 8 to 10 percentage points for margin insurance, and about 2 percentage points for production insurance. The average marginal effect on the probability of a non-zero FR level remains similar across policy periods for both BRM programs.

Average marginal effect estimates are similar for grain and oilseed producers and cattle operations, but there are several notable distinctions. The average marginal effects of margin insurance on FR levels are slightly higher for cattle operations than those for the pooled sample and the grain and oilseed producers by 3 to 7 percentage points. The average marginal effect of margin insurance on the probability of non-zero FR is larger by almost 3 percentage points for cattle operations. The larger effect of margin insurance on cattle operations may be in part due to the lack of alternative BR management tools available to cattle operators relative to other farm types and the high level of capital inputs necessary for running a cattle operation.

Another notable point is the significant marginal effect of production insurance on FR levels and probability of non-zero FR. In 2013, Growing Forward 2 introduced new guidelines for provinces to provide livestock production insurance. Prior to this, production insurance was mainly designed for crops and horticulture producers. Private price insurance options for livestock exist, but production insurance is not common. Significant results for production insurance imply cattle producers may supplement their income with crop production or may be producing their feed for feedlot operations.

5.1.2 Debt-to-Asset Ratio

The estimates from the BRM programs and financial risk analysis using the debt-to-asset ratio as a measure of FR yield results consistent with the hypothesized relationship but are not as robust across the different samples. In general, BRM program participation is correlated with a higher level of FR. Results should be interpreted as percentage point changes to the debt-to-asset ratio, or FR.

Only margin insurance is significant for the pooled farm type sample. Margin insurance enrolment is correlated with a 2.4, 1.6, and 2.2 percentage point increase in the level of FR for the APF, Growing Forward and pooled policy periods, respectively. Results for the farm-specific samples are distinct and unsurprising. For grain and oilseed producers, production insurance enrolment is correlated with a 2 to 2.9 percentage point increase in FR across the policy periods, while margin insurance was not significant except in the pooled policy sample at a 5% significance level. For cattle operations, margin insurance is correlated with a 1.2 percentage point increase for the APF period, and 1 percentage point increase for the pooled period sample. Production insurance does not have a significant effect on the level of FR for cattle producers.

5.1.3 Summary of BRM Programs and Financial Risk Results

The two different theoretical approaches to risk balancing by Gabriel and Baker (1980) and Collins (1985) yield two different measure of FR and models. Results show that BRM program participation is correlated with an increase in FR under both FR measures. The main distinction between the results of the two FR measures is the significance of increased FR associated with each BRM program. Higher FR is associated with margin insurance and production insurance participation for the pooled sample, grain and oilseed producers, and cattle operations when using the fixed debt obligations measure of FR. A greater magnitude in the level of FR associated with margin insurance is observed for cattle operations. Results from the debt-to-asset measure of FR vary in the significance of greater FR across samples and insurance types. Results using debt-to-asset show greater FR is associated with production insurance for grain and oilseed producers and margin insurance for cattle operations.

5.1.4 Discussion

Results show that, across certain policy periods and farm type sample groups, BRM program participation is correlated with higher levels of FR, but it cannot be said that BRM programs lead farms to take on greater FR. While a causal relationship cannot be concluded from the results, the positive correlation between BRM program participation and higher FR provides policy relevant insights into the sample of BRM program participants. BRM program participants in the sample have higher levels of FR relative to those that do not participate.

Policymakers should consider the distinct risk profile of participants when designing risk management programs if higher FR levels are a characteristic of BRM program participants, regardless of whether higher FR is caused by participation. The Canadian suite of BRM programs have been created to mitigate and manage BR but not FR. A total risk approach to risk management programming may be beneficial for the typical farm that would choose to enrol in a BRM program.

5.1.5 Limitations

5.1.5.1 Endogeneity

Endogeneity between BRM program participation and FR levels is an issue that limits interpretation of the results. Causality between BRM program participation and FR cannot be drawn because BRM program participation is not exogenously determined. Farms enrolling themselves in BRM programs causes issues associated with self-selection. The sample of farms that choose to participate in BRM programs may consist of operations that have higher FR than those that do not participate. If BRM program participation and higher levels of FR are positively correlated with an unobserved variable that is not captured in the data, then BRM program participation would be correlated with higher levels of FR without program participation being the cause of higher FR.

Previous empirical studies have used panel data to observe whether an increase in FR from one year to the next is correlated with BRM program participation or payout in the previous year, but this would not solve the issue of endogeneity due to self-selection (Uzea et al., 2014). Further research is required to find an instrument for BRM program participation that is exogenous from FR.

Moral hazard cannot be convincingly determined without strong evidence of a causal relationship between BRM programs and higher levels of FR. If participation in BRM programs is causing farms to adjust their FR upward, then moral hazard may be present among the sample of participant, but this cannot be determined through the analysis conducted.

5.1.5.2 Interest Payments over NOI

There are two issues with using the fixed debt obligations or interest payments over NOI measure of FR. First, interest payments of net-operating-income may not be a good measure of FR when only observing a cross section. NOI can fluctuate significantly for some farms year to year. Therefore, an observation of FR from just one year may not accurately represent a farm's state of FR. The debt-to-assets measure of FR would likely fluctuate less from year to year for an individual farm, so the analysis using this measure can be viewed as a robustness test.

Second, results from the tobit model may be biased due to the dropped observations. Farms with zero and negative values recorded for their net-operating-income are dropped because FR is measured by dividing fixed financial obligations by net-operating-income. If program participation is correlated with a higher (lower) FR level or probability of non-zero FR for farms with zero or negative net-operating-incomes, then the results obtained without these observations would be biased downward (upward). A bias would imply that farms with zero or negative net-operating-income values behave differently than operations with positive net-operating-incomes after controlling for the other variables included in the model. This is plausible as there can be unobservable characteristics that are correlated an operation's inability to break even, the decision to participate in BRM programs, and the level of FR. Alternatively, zero and negative values may only be due to random shocks such as weather and therefore would not affect the estimates. To be confident in the results, they should be interpreted as reflective of operations only with positive net-operating-incomes.

5.2 BRM Program Participation and Investment Analysis

BRM program enrollment is correlated with a positive increase in the likelihood of an investment being made in the same survey period. The level and significance of the average marginal effects of BRM programs on investment vary between sample periods and types of operations, but results are generally robust.

Tables (5.3) and (5.4) provide estimates for the average marginal effect of production and margin insurance participation on the likelihood of an investment being made. Estimates are interpreted as percentage point changes in the probability of the investment outcome. The tables include the directional effect and significance for the non-binary control variables while the average marginal effects are not. Table (5.3) displays the average partial effect estimates when using the FFS binary investment variable. The model is run for grain and oilseed producers, cattle operations, and a pooled farm type sample across the APF, Growing Forward and pooled policy periods. Table (5.4) provides a comparison of results under alternative investment variables across different policy periods using only the pooled farm type sample.

5.2.1 Farm-Type Samples with FFS Investment Variable

The first three columns of Table (5.3) provide the estimates for the pooled farm type sample across different policy periods. The margin insurance enrolment is correlated with a 4.3, 1.9, and 2.9 percentage point increase in the likelihood of an investment being made for the APF, Growing Forward, and pooled policy period, respectively. Production insurance enrolment is correlated with a 3.7, 4.3, and 3.9 percentage point increase in the likelihood of an investment being made for the same policy period sample groups.

For grain and oilseed producers, average marginal effects for production insurance are significant, while those for margin insurance are not. Production insurance enrolment is correlated with a 4.8 percentage point increase in the likelihood of investment for the APF policy period, and a 3.3 percentage point increase for the pooled policy period. The marginal effect is not significant for the Growing Forward policy period. These results are consistent with the BRM programs and FR analysis results using the debt-to-asset measure of FR which found production insurance to be positive and significant for grain and oilseed producers, while margin insurance was not significant.

For cattle operations, both margin insurance and production insurance enrolment are correlated with an increased likelihood of investment. Margin insurance is correlated with a 9 percentage point increase for the APF period and a 4.3 percentage point increase in the Growing Forward period. On the other hand, production insurance enrolment is correlated with a 2.8 percentage point increase for the APF period and a 7.7 percentage point increase in the likelihood of investment for the Growing Forward period. The magnitude of the average marginal effect for margin insurance decreased by roughly 5 percentage points between APF and Growing Forward,

Table 5.3: BRM Program Participation and Investment Logit Results

FFS Investment Variable	All Farm Types			Grains & Oilseeds			Cattle		
Variable	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled
AME of Margin Insurance	0.043*** (0.010)	0.019* (0.010)	0.029*** (0.007)	0.013 (0.019)	0.021 (0.014)	0.016 (0.012)	0.090*** (0.017)	0.043** (0.019)	0.068*** (0.013)
AME of Production Insurance	0.037*** (0.010)	0.043*** (0.010)	0.039*** (0.007)	0.048** (0.020)	0.022 (0.016)	0.033*** (0.012)	0.028** (0.015)	0.077*** (0.021)	0.046*** (0.013)
Profit Margin	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***
Debt-to-TGR	(+)***	(+)***	(+)***	(+)**	(+)***	(+)***	(+)**	(+)	(+)**
Diversity Index	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***
Liquidity	(+)***	(+)	(+)**	(+)***	(+)	(+)*	(+)	(-)	(+)
Years of Management Experience	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***
Categorical Variables									
Province	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Year	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Revenue Class	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Farm Type	*yes*	*yes*	*yes*						
Sample Size	39035	25479	64514	8588	8117	16705	11902	5040	16942

***, **, * statistical significance at 1%, 5%, and 10% levels respectively

Table 5.4: BRM Participation and Investment Logit Results with Alternative Investment Variables

Variable	FFS Investment			Net Capital Investment			Net Machinery Investment			Machine Purchase		
	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled
AME of Margin Insurance	0.043*** (0.010)	0.019* (0.010)	0.029*** (0.007)	0.042*** (0.010)	0.015 (0.010)	0.027*** (0.007)	0.037*** (0.010)	0.022** (0.010)	0.028*** (0.007)	0.037*** (0.010)	0.025** (0.010)	0.029*** (0.007)
AME of Production Insurance	0.037*** (0.010)	0.043*** (0.010)	0.039*** (0.007)	0.043*** (0.010)	0.047*** (0.010)	0.044*** (0.007)	0.044*** (0.010)	0.049*** (0.010)	0.045*** (0.007)	0.042*** (0.010)	0.047*** (0.010)	0.044*** (0.007)
Profit Margin	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***
Debt-to-TGR	(+)***	(+)***	(+)***	(+)***	(+)***	(+)***	(+)***	(+)***	(+)***	(+)***	(+)***	(+)***
Diversity Index	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***
Liquidity	(+)***	(+)	(+)**	(+)***	(+)	(+)**	(+)***	(+)	(+)***	(+)***	(+)	(+)***
Years of Management Experience	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***	(-)***
Categorical Variables												
Province	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Year	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Revenue Class	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Farm Type	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Sample Size	39035	25479	64514	39035	25479	64514	39035	25479	64514	39035	25479	64514

***, **, * statistical significance at 1%, 5%, and 10% levels respectively

while the average marginal effect for production insurance increased by about 5 percentage points between the two policy periods. The increase in the marginal effect of production insurance may be in part due to adjustments made to AgriInsurance following Growing Forward 2 which tailored the program for livestock, thus increasing its effect on BR. Alternatively, production insurance may have become more relevant to cattle operations' business decisions if the income share affected by production insurance increased. As production insurance is commonly designed for crops, a greater share of income arising from crop production may lead to a greater influence of production insurance on investment behaviour.

The rows below the average marginal effects for the BRM programs provide the sign and significance of the coefficients for each non-categorical covariate, while the average marginal effects are not calculated.[1] The sign and significance still provide interesting insights into factors correlated with the decision to invest. Results show that a farm's net operating income over total gross revenue is significant and negatively correlated with the likelihood of an investment being made, contrary to what was hypothesized. Higher profit margin measures may be correlated with higher efficiency farms which are less likely to invest. Debt-to-total gross revenue is significant and positively correlated with the likelihood of investment. The positive correlation is also contrary to the hypothesized effect, as the expected sign was negative. There is a simultaneity issue with this variable since investment can increase debt-to-total gross revenue when both are only observed in the same narrow time frame. Diversification is significant and negatively correlated with the likelihood of investment, while the expected sign of the diversity index coefficient was expected to be positive. In general, studies examining farm diversification find that farms with greater diversity tend to be smaller and less wealthy (Pope and Prescott, 1980; Mishra et al., 2004; Melhim et al., 2009). The theory that farms give up on gains from economies of scale in favour of risk reduction through diversity is used to explain this observation. Farms with higher diversification may be less likely to invest in capital to grow their operations. Liquidity is positively correlated with the likelihood of investment but is not significant across all sample groups. Liquidity is significant for the pooled farm type sample across the APF and pooled policy period. It is also significant for the APF policy period, and pooled policy period at the 10%

[1]Average marginal effects were not calculated due to limited time with the data and limited capability of the hardware used for the analysis.

significance level, for grain and oilseed producers. The positive correlation is consistent with the hypothesized sign. Liquidity is not significant for cattle operations. This may be due to how working capital is calculated for the liquidity measure. The current assets and current debts used to calculate working capital are not as relevant to livestock operations as they are to crop production. Year of management experience is significant and negatively correlated with investment, as expected. Of the categorical fixed effect variables, the coefficients for revenue class were consistently significant and worth noting. As revenue increases by each category, the magnitude of the effect on the likelihood of investment increases relative to the lowest revenue category.

5.2.2 Alternative Capital Investment Variables

Results using the alternative investment variables are consistent with the results obtained using the FFS investment variable. The magnitude of the average partial effects differs slightly from results using the FFS investment variable. The significance and sign of the other non-categorical variables are robust across investment variables.

While most of the results do not change, the significance of margin insurance enrolment on investment behaviour over the Growing Forward policy period varies across investment variables. Margin insurance enrolment for the Growing Forward period is correlated with a 1.9 percentage point increase in the likelihood of investment using the FFS investment variable and is only significant at the 10 percent significance level. The average marginal effect for margin insurance is not significant over the Growing Forward period for the net capital investment variable, but it is significant at the 5 percent significance level using the net machinery investment variable and the machine purchase variable. Margin insurance is correlated with a 2.2 percentage point increase in the likelihood of net machinery investment being positive and a 2.5 percentage point increase in the likelihood of an operation purchasing machinery. The way machinery investments were financed during the Growing Forward period may explain the greater significance of margin insurance on machinery related investment variables relative to less specific investment variables. If machinery investments are commonly financed through debt, more so than other forms of capital, then machinery investments are more directly linked to FR, and therefore the FR and BRM program enrolment relationship analyzed above.

Production insurance generally has a larger average marginal effect than margin insurance across the four capital investment variables. These results may reflect how production insurance and margin insurance, specifically AgriStability during the Growing Forward period, are designed to interact. When calculating an operation's margin to determine if they are to receive an indemnity from margin insurance, payouts from production insurance are included as revenue. This means that a payout from production insurance reduces the likelihood of a payout from margin insurance. The lower likelihood of a payout from margin insurance when an operation is also enrolled in production insurance may reduce the effect of margin insurance on investment behaviour.

5.2.3 Discussion

5.2.3.1 Causal Relationship between BRM Program Participation and Investment

It is difficult to isolate the effect of BRM programs on FR and investment due to the self-selection of BRM program participants and the timing of participation and investment decisions. The risk balancing theory states that in the event of an exogenous shock to a component of total risk, a different component will adjust to maintain the accepted level of total risk (Gabriel and Baker, 1980). Neither BRM program participation or capital investment can be considered as exogenous shocks to a firm's total risk portfolio. The risk balancing framework can provide insight into how BR and FR adjust due to program participation and investment decisions, but a causal relationship between the variables is difficult to draw without exogenous shocks that effect BRM program participation or investment. The analysis conducted in this paper cannot show that a reduction in BR due to program participation caused FR though investment to increase. Likewise, it cannot show that an increase in FR due to investment caused BR to decrease due to subsequent program participation.

The timing of BRM program participation and investment decision makes it difficult to isolate a causal effect of BRM program participation on investment behaviour and vice versa. The data is in the form of repeated cross-sections with a new sample selected each survey year. We can see whether an operation enrolled in a BRM program and made an investment sometime within the survey reference year, but we cannot tell when within this period each decision was made. The deadline for enrolling in margin insurance and production insurance is generally in April or early May. Investment can happen before or after enrolment within the survey reference year. That said, panel data or other data where the specific timing of investment and BRM program participation is known may not solve the problem. The decision to invest or participate is not necessarily made at the time investment, or enrollment occurs.

As stated above, neither investment or BRM program enrolment are exogenously determined for a farm. The decision to participate in a BRM program and the decision to invest may be a joint decision, even if one decision is executed before the other. For example, an operation intending on making a large investment may take steps to ensure a level of income to finance the resulting debt and enrol in a BRM program. Similarly, knowing that BRM programs are available, an operation may be encouraged to invest. With panel data, the order of BRM program enrolment and investment occurring could be known but would not necessarily prove a causal relationship.

5.2.3.2 BRM Programs Help Farms that Invest

The policy-relevant interpretation of the results is that BRM programs help farms that want to invest. A multitude of factors in agriculture determine investment behaviour, and while there is evidence that income volatility, or BR, is a factor in the likelihood and level of capital investment made by farms, it is unlikely to be the driving factor for investment. BRM programs are designed to reduce income volatility which can facilitate investment through mechanisms discussed above such as credit availability and the ability to finance debt. Farms that want to invest may enrol in BRM programs while BRM programs may provide the opportunity for a farm to invest. This interpretation does not speak to causality which is consistent with the empirical analysis. The positive correlation between BRM program participation and investment indicates that farm operators who are enrolled in BRM programs are more likely to invest without implying a causal relationship. In this context, BRM programs do more than fulfil their short-term purpose of managing business risk. BRM programs are tools that can be used when making business decisions such as investment. BRM programs can have policy implications regarding growth and innovation within the agricultural industry.

5.2.3.3 Perceived Business Risk Reduction through BRM Programs

While this paper does not directly address risk balancing behaviour in the empirical analysis, it is worth discussing risk balancing within the BRM program and investment relationship. Under a risk balancing framework, BRM program participation can be viewed as a reduction in an operation's BR, relative to not participating. The assumption that BRM programs reduce BR is needed. A weaker alternative assumption is proposed in which BRM program participation causes a perceived BR reduction. This weaker assumption may be sufficient to establish risk balancing if risk balancing is a behaviour that is not strongly rooted in financial figures. Risk balancing without financial analysis is an unreasonable assumption for most businesses but may be valid in the case of agricultural operations as there is evidence of poor business planning and record keeping among Canadian farms (Serecon Management Consulting Inc., 2009). If higher FR is correlated with perceived BR reductions, this may have negative implications for the overall financial health of farms. Previous studies highlight the issue of risk balancing and BRM program participation, finding that BRM programs may reduce the use of other risk-mitigating tools and can increase the likelihood of default (Featherstone et al., 1988; Fernandez-Villaverde et al., 2011; Uzea et al., 2014; Vercammen, 2007). This paper takes the view that benefits from risk balancing can arise through investment, but if BRM program participation does not reduce BR, the potential benefits from an investment may be outweighed by the increase in total risk due to increased FR without the offsetting reduction in BR.

5.2.4 Limitations

5.2.4.1 Observed Variables and Correlation

As the data is repeated cross-sections, BRM program enrolment and investment occurring outside of the survey year for a specific farm operation will not be observed. Therefore, the correlation between BRM program enrolment and investment is only observed when both occur within the same survey year. This is a shortcoming of the analysis as the relationship between the two decisions would not be restricted by this survey reference period. Panel data may help solve this problem by expanding the period in which BRM program participation and investment can be observed, but the determining a limit to this period would require further research.

5.2.4.2 Endogeneity

Two endogeneity issues may present in the analysis. One is due to omitted variables and the other due to simultaneity. Endogeneity may cause biased estimates of the relationship between BRM program enrollment and investment.

The models used in the analysis may omit unobservable characteristics of some operations that are correlated with the decision to enrol in a BRM program and the decision to invest. For example, operations with better-established business plans or those that use professional accounting firms may be more focused on growing their farm business and are therefore more likely to make investments. Such operations may also have better information on BRM programs and would be more likely to participate. Another source of endogeneity may arise from a period of high income for an operation prior to the observable survey year. Periods of high income may encourage a farm to enrol in margin insurance since their coverage is based on historical margins. High income periods may also increase the likelihood of investment due to increased availability of capital. BRM program enrolment and investment behaviour would be positively correlated to high income periods preceding the observable survey year and, therefore, to each other. These potential sources of endogeneity cause BRM program participation and investment to be correlated with the error term in the latent model for the logit, meaning the assumed logistic distribution of this error term is incorrect. The missing variable bias arises from self-selection of BRM program participants.

BRM program enrolment and investment may be a joint decision, as discussed above, and would cause a simultaneity issue. Estimating a model with investment as the dependent variable and BRM program enrolment as the independent variable will cause BRM program enrolment to be correlated with the error term, possibly biasing the results.

5.3 Evaluating Results with respect to Policy Goals

As BRM programs are a policy tool, the question arises of whether the results of this paper align with the stated policy goals. This paper does not investigate the primary goal of reduced income volatility, but it does address two specific general principles of risk management programming stated in the framework agreement for Growing Forward. The first general principle stated that “programs should minimize moral hazard” (Agriculture and Agri-Food Canada, 2008). Moral hazard refers to the change in behaviour when faced with a reduction in risk. This paper finds that BRM program participation is correlated with higher levels of FR and an increase in the likelihood of an investment being made. Moral hazard cannot definitively be said to exist without establishing a causal relationship between BRM program participation and higher levels of FR or investment behaviour.

The second general principle stated that “programs should contribute to market-oriented adjustments and adoption of technological innovations” (Agriculture and Agri-Food Canada, 2008). Although we cannot tell if the capital investments in our sample are in technological innovations, it is feasible that some are, especially machine investments. In the context of larger agricultural policy initiatives of innovation and growth, the positive correlation between BRM program enrolment and investment behaviour provides evidence that BRM programs are aligned with such policy goals.

Further analysis may be done to determine whether an investment is financed through debt, therefore effecting an operation’s level of FR. Analysis of productivity gains due to investments financed through debt may provide better evidence of the long-term benefits of BRM programs such as increased productivity and efficiency. Possible capitalization of these productivity gains could be addressed as well.

6 CONCLUSION

Studies have shown that Canadian BRM programs are likely fulfilling their primary role of reducing BR faced by agricultural producers (Agriculture and Agri-Food Canada, 2012; Uzea et al., 2014). Through risk balancing behaviour, reductions in BR through BRM program enrolment may be correlated with other risk influencing farm behaviour. While previous studies frame BRM programs and risk balancing as having neutral or even negative consequences regarding farm behaviour and risk, this paper finds BRM program enrolment to be correlated with increased likelihood of investment. The positive relationship between BRM program enrolment and investment has implication for farm's productivity, long-term financial health, and growth.

A causal effect cannot be drawn between BRM program enrolment and investment behaviour based on the analysis. BRM programs are self-enrolled programs that can be factored into many farm-level decisions, with enrollment as a farm-level decision itself. BRM program enrolment is very likely an endogenous decision, so a unidirectional causal effect on investment would not be a policy-relevant measure as it does not capture the entire relationship between the two variables. While we cannot say how one directly affects the other, the positive correlation between BRM program enrolment and investment behaviour highlights that policies targeted at one aspect of the agricultural industry may be indirectly related to others. In the case of agricultural BRM programs, policymakers should keep in mind the linkages between factors that influence risk, as well as farm-level decisions that are influenced by risk.

Despite data limitations and shortcomings of the analysis, this paper provides evidence of a positive relationship between BRM program enrolment and investment behaviour. The indirect effects of adjusting risk on farm-level behaviour and decision-making are important to consider when designing policy and evaluating existing programs. It is also important to consider the context in which farm decisions are viewed as the relationship between BRM program enrolment and investment can be viewed as an example of moral hazard or farms optimizing their business through risk management tools.

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APPENDIX

Table A.1: Coefficients for Tobit Model using Fixed Debt Obligations FR Measure

	All Farm Types			Grains & Oilseeds			Cattle		
Variable	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled
Margin Insurance	0.366***	0.143***	0.234***	0.353***	0.132*	0.206***	0.619***	0.258***	0.435***
	(0.064)	(0.049)	(0.039)	(0.096)	(0.075)	(0.063)	(0.126)	(0.070)	(0.072)
Production Insurance	0.201***	0.140***	0.180***	0.209*	0.220**	0.227***	0.211**	0.184**	0.233***
	(0.063)	(0.051)	(0.039)	(0.110)	(0.104)	(0.077)	(0.103)	(0.072)	(0.068)
Profit Margin	-5.091***	-3.492***	-4.306***	-4.702***	-3.563***	-4.080***	-4.571***	-3.007***	-3.863***
	(0.295)	(0.270)	(0.194)	(0.525)	(0.560)	(0.377)	(0.403)	(0.274)	(0.259)
Diversity Index	-0.434***	-0.172**	-0.297***	-0.470***	-0.417***	-0.438***	-0.239	0.175	-0.068
	(0.132)	(0.079)	(0.076)	(0.179)	(0.132)	(0.108)	(0.218)	(0.143)	(0.139)
Debt-to-TGR	0.753***	0.477***	0.584***	0.679***	0.553***	0.588***	0.842***	0.401***	0.590***
	(0.065)	(0.084)	(0.053)	(0.102)	(0.170)	(0.104)	(0.119)	(0.056)	(0.065)
Liquidity	-0.442***	-0.170***	-0.277***	-0.461***	-0.203***	-0.298***	-0.306***	-0.166***	-0.252***
	(0.068)	(0.036)	(0.045)	(0.118)	(0.055)	(0.063)	(0.085)	(0.057)	(0.057)
Years of Management Experience	-0.019***	-0.013***	-0.017***	-0.020***	-0.016***	-0.018***	-0.017***	-0.012***	-0.017***
	(0.003)	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)
Province (Base: Ontario)									
Atlantic Canada	0.255***	0.292***	0.274***	0.544*	0.144	0.191	0.858***	0.325**	0.635***
	(0.086)	(0.074)	(0.057)	0.328)	(0.188)	(0.164)	(0.217)	(0.133)	(0.138)
Quebec	0.009	0.103**	0.062	0.105	0.071	0.083	0.590***	0.200*	0.382***
	(0.082)	(0.044)	(0.045)	(0.138)	(0.090)	(0.077)	(0.166)	(0.108)	(0.097)
Manitoba	0.546***	0.344***	0.445***	0.206	0.258*	0.231**	1.335***	0.465***	0.965***
	(0.109)	(0.078)	(0.066)	(0.133)	(0.134)	(0.094)	(0.248)	(0.113)	(0.150)

Saskatchewan	0.677***	0.436***	0.559***	0.446***	0.462***	0.465***	1.302***	0.487***	0.918***
	(0.121)	(0.086)	(0.073)	(0.169)	(0.175)	(0.122)	(0.206)	(0.104)	(0.122)
Alberta	0.260***	0.248**	0.249***	0.124	0.314	0.234*	0.754***	0.217**	0.502***
	(0.081)	(0.105)	(0.065)	(0.110)	(0.198)	(0.122)	(0.159)	(0.094)	(0.095)
British Columbia	-0.062	0.034	-0.028	0.423	0.065	0.215	0.437**	0.007	0.185
	(0.122)	(0.095)	(0.074)	(0.257)	(0.277)	(0.195)	(0.186)	(0.197)	(0.137)
<u>Revenue Class (Base: $25,000 to $99,999)</u>									
$100,000 to $249,999	0.960***	0.644***	0.837***	0.850***	0.656***	0.757***	0.691***	0.544***	0.677***
	(0.166)	(0.079)	(0.079)	(0.156)	(0.134)	(0.103)	(0.126)	(0.117)	(0.096)
$250,000 to $999,999	1.320***	0.897***	1.177***	1.179***	1.094***	1.160***	1.138***	0.520***	0.893***
	(0.162)	(0.118)	(0.113)	(0.251)	(0.242)	(0.170)	(0.244)	(0.101)	(0.152)
$1,000,000 and over	1.593***	1.001***	1.357***	1.253***	1.195***	1.274***	2.057***	0.654***	1.348***
	(0.220)	(0.145)	(0.140)	(0.227)	(0.300)	(0.188)	(0.575)	(0.128)	(0.282)
<u>Farm Type (Base: Grains & Oilseeds)</u>									
Horticulture	0.045	-0.077	-0.044						
	(0.091)	(0.051)	(0.050)						
Dairy	0.335***	0.056	0.185***						
	(0.106)	(0.044)	(0.054)						
Cattle	0.405***	0.231***	0.329***						
	(0.078)	(0.049)	(0.046)						
Hog	0.190*	0.275***	0.221***						
	(0.113)	(0.095)	(0.074)						
Poultry	0.119	0.016	0.038						
	(0.156)	(0.069)	(0.081)						
<u>Year (Base: changes between samples)</u>									

2003	Base Year		Base Year	Base Year		Base Year	Base Year		Base Year
2004	-0.174** (0.071)		-0.110* (0.061)	-0.274*** (0.106)		-0.198** (0.094)	-0.239* (0.130)		-0.118 (0.103)
2005	-0.176** (0.082)		-0.106 (0.074)	-0.251*** (0.121)		-0.154 (0.111)	-0.236* (0.139)		-0.138 (0.120)
2006	-0.024 (0.097)		0.045 (0.092)	-0.040 (0.164)		0.039 (0.180)	-0.025 (0.158)		0.082 (0.147)
2007	-0.124 (0.077)		-0.066 (0.066)	-0.128 (0.108)		-0.088 (0.103)	-0.112 (0.146)		0.025 (0.125)
2008		Base Year	-0.187** (0.083)		Base Year	-0.149 (0.146)		Base Year	-0.198 (0.122)
2009		-0.036 (0.072)	-0.177*** (0.060)		0.027 (0.117)	-0.078 (0.092)		0.035 (0.119)	-0.109 (0.116)
2010		-0.119* (0.071)	-0.259*** (0.060)		-0.113 (0.121)	-0.206** 0.085)		0.002 (0.128)	-0.133 (0.128)
2011		-0.233** (0.093)	-0.422*** (0.067)		-0.291 (0.178)	-0.433*** (0.100)		-0.184* (0.110)	-0.382*** (0.116)
2013		-0.312*** (0.091)	-0.505*** (0.067)		-0.267 (0.164)	-0.404*** (0.097)		-0.274*** (0.102)	-0.455*** (0.114)
2015		-0.182*** (0.084	-0.350*** (0.066)		-0.167 (0.173)	-0.296*** (0.104)		-0.140 (0.101)	-0.271*** (0.104)
Constant	-0.213 (0.222)	-0.086 0.181)	-0.087 (0.164)	0.333 (0.299)	-0.034 (0.335)	0.205 (0.269)	-0.809** (0.385)	-0.065 (0.214)	-0.342 (0.234)
Sample Size	34415	29083	63498	7486	9169	16655	8551	4805	13356

***, **, * statistical significance at 1%, 5%, and 10% levels respectively

Table A.2: Coefficients for Linear Regression Model using Debt-to-Asset Ratio FR Measure

Variable	All Farm Types			Grains & Oilseeds			Cattle		
	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled
Margin Insurance	0.024*** (0.004)	0.016*** (0.005)	0.022*** (0.003)	0.005 (0.006)	0.014 (0.010)	0.014** (0.006)	0.011** (0.006)	0.007 (0.005)	0.010*** (0.004)
Production Insurance	-0.003 (0.004)	0.002 (0.005)	0.002 (0.003)	0.029*** (0.005)	0.020*** (0.006)	0.023*** (0.004)	0.004 (0.006)	-0.006 (0.005)	0.002 (0.004)
Profit Margin	-0.005 (0.008)	-0.005 (0.005)	-0.008* (0.005)	-0.020* (0.012)	-0.018 (0.012)	-0.024** (0.010)	0.020*** (0.006)	0.003 (0.003)	0.007** (0.003)
Diversity Index	0.017* (0.009)	0.030*** (0.011)	0.023*** (0.007)	-0.003 (0.012)	0.002 (0.018)	0.0005 (0.011)	0.011 (0.011)	0.012 (0.009)	0.010 (0.008)
Debt-to-TGR	0.074*** (0.003)	0.053*** (0.004)	0.060*** (0.003)	0.077*** (0.005)	0.051*** (0.009)	0.059*** (0.007)	0.064*** (0.003)	0.046*** (0.002)	0.053*** (0.002)
Liquidity	-0.044*** (0.005)	-0.023*** (0.006)	-0.030*** (0.006)	-0.058*** (0.011)	-0.026** (0.012)	-0.035*** (0.012)	-0.028*** (0.004)	-0.013*** (0.004)	-0.019*** (0.003)
Years of Management Experience	-0.003*** (0.0002)	-0.003*** (0.0002)	-0.003*** (0.0001)	-0.003*** (0.0002)	-0.003*** (0.0003)	-0.003*** (0.0002)	-0.003*** (0.0002)	-0.002*** (0.0002)	-0.003*** (0.0001)
Province (Base: Ontario)									
Atlantic Canada	0.032*** (0.006)	0.052*** (0.010)	0.042*** (0.006)	0.024 (0.019)	0.056*** (0.019)	0.054*** (0.014)	0.013** (0.006)	0.018** (0.008)	0.016*** (0.005)
Quebec	0.045*** (0.006)	0.047*** (0.009)	0.046*** (0.005)	0.043*** (0.007)	0.020 (0.017)	0.029*** (0.010)	0.047*** (0.008)	0.055*** (0.011)	0.051*** (0.007)
Manitoba	0.057*** (0.007)	0.011 (0.007)	0.032*** (0.005)	0.065*** (0.008)	0.010 (0.011)	0.032*** (0.007)	0.064*** (0.015)	0.030*** (0.008)	0.049*** (0.009)
Saskatchewan	0.051*** (0.005)	0.00002 (0.007)	0.024*** (0.005)	0.065*** (0.007)	0.012 (0.010)	0.033*** (0.007)	0.050*** (0.007)	0.009 (0.007)	0.032*** (0.005)

Alberta	0.00002	-0.030***	-0.015***	0.017***	-0.018*	-0.005	-0.015***	-0.031***	-0.020***
	(0.005)	(0.007)	(0.004)	(0.006)	(0.011)	(0.007)	(0.005)	(0.007)	(0.004)
British Columbia	-0.042***	-0.054***	-0.050***	0.027	0.0003	0.010	-0.041***	-0.053***	-0.045***
	(0.006)	(0.011)	(0.006)	(0.021)	(0.024)	(0.016)	(0.007)	(0.009)	(0.006)
<u>Revenue Class (Base: $25,000 to $99,999)</u>									
$100,000 to $249,999	0.072***	0.058***	0.065***	0.062***	0.037***	0.050***	0.082***	0.069***	0.075***
	(0.004)	(0.006)	(0.004)	(0.006)	(0.010)	(0.006)	(0.008)	(0.005)	(0.005)
$250,000 to $999,999	0.124***	0.119***	0.121***	0.112***	0.095***	0.103***	0.152***	0.135***	0.141***
	(0.003)	(0.007)	(0.004)	(0.005)	(0.011)	(0.007)	(0.008)	(0.008)	(0.005)
$1,000,000 and over	0.212***	0.199***	0.203***	0.155***	0.146***	0.151***	0.249***	0.257***	0.253***
	(0.005)	(0.008)	(0.005)	(0.010)	(0.013)	(0.009)	(0.011)	(0.012)	(0.009)
<u>Year (Base: changes between samples)</u>									
2003	Base Year		Base Year	Base Year		Base Year	Base Year		Base Year
2004	-0.002		-0.001	0.012		0.007	0.0001		0.003
	(0.005)		(0.005)	(0.009)		(0.009)	(0.007)		(0.006)
2005	-0.012***		-0.013***	-0.005		-0.012*	-0.017***		-0.018***
	(0.004)		(0.004)	(0.008)		(0.007)	(0.006)		(0.006)
2006	-0.012**		-0.013**	0.001		-0.010	-0.012		-0.011
	(0.005)		(0.005)	(0.007)		(0.007)	(0.010)		(0.010)
2007	-0.018***		-0.020***	-0.008		-0.021***	-0.029***		-0.029***
	(0.005)		(0.005)	(0.007)		(0.007)	(0.007)		(0.007)
2008		Base Year	-0.022***		Base Year	-0.028***		Base Year	-0.021***
			(0.005)			(0.007)			(0.007)
2009		-0.004	-0.023***		0.016	-0.010		-0.012*	-0.032***
		(0.006)	(0.004)		(0.010)	(0.007)		(0.007)	(0.006)

2010		-0.009 (0.006)	-0.028*** (0.004)		0.005 (0.010)	-0.022*** (0.007)		-0.016** (0.008)	-0.037*** (0.006)
2011		-0.025*** (0.005)	-0.045*** (0.004)		-0.017** (0.006)	-0.043*** (0.006)		-0.038*** (0.006)	-0.058*** (0.006)
2013		-0.024*** (0.006)	-0.044*** (0.005)		-0.019*** (0.007)	-0.047*** (0.006)		-0.030*** (0.008)	-0.051*** (0.007)
2015		-0.018 (0.013)	-0.038*** (0.011)		0.003 (0.024)	-0.026 (0.023)		-0.051*** (0.008)	-0.070*** (0.007)
Constant	0.109*** (0.010)	0.130*** (0.011)	0.136*** (0.008)	0.094*** (0.018)	0.128*** (0.020)	0.137*** (0.017)	0.126*** (0.014)	0.142*** (0.014)	0.148*** (0.010)
Sample Size	46884	39067	85951	10152	12080	22232	14114	7831	21945

***, **, * statistical significance at 1%, 5%, and 10% levels respectively

Table A.3: Coefficients for BRM Program Participation and Investment Logit

FFS Investment Variable	All Farm Types			Grains & Oilseeds			Cattle		
Variable	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled
Margin Insurance	0.194*** (0.046)	0.087* (0.045)	0.133*** (0.032)	0.060 (0.087)	0.098 (0.068)	0.075 (0.053)	0.380*** (0.073)	0.186** (0.084)	0.292*** (0.055)
Production Insurance	0.169*** (0.044)	0.200*** (0.047)	0.179*** (0.032)	0.220** (0.090)	0.103 (0.073)	0.154*** (0.057)	0.121* (0.066)	0.335*** (0.094)	0.195*** (0.054)
Profit Margin	-0.206*** (0.049)	-0.223*** (0.054)	-0.209*** (0.036)	-0.340*** (0.107)	-0.330*** (0.099)	-0.330*** (0.073)	-0.194*** (0.061)	-0.307*** (0.090)	-0.233*** (0.050)
Diversity Index	0.056*** (0.013)	0.046*** (0.010)	0.048*** (0.008)	0.065** (0.029)	0.061*** (0.017)	0.060*** (0.015)	0.039** (0.019)	0.022 (0.017)	0.029** (0.013)
Debt-to-TGR	-0.721*** (0.093)	-0.812*** (0.104)	-0.752*** (0.069)	-0.713*** (0.161)	-0.790*** (0.159)	-0.744*** (0.113)	-0.598*** (0.142)	-0.591*** (0.187)	-0.593*** (0.113)
Liquidity	0.113*** (0.030)	0.021 (0.020)	0.053** (0.022)	0.192*** (0.059)	0.036 (0.046)	0.091* (0.047)	0.057 (0.038)	-0.018 (0.026)	0.008 (0.022)
Years of Management Experience	-0.010*** (0.002)	-0.013*** (0.001)	-0.011*** (0.001)	-0.009*** (0.003)	-0.012*** (0.002)	-0.010*** (0.002)	-0.010*** (0.002)	-0.020*** (0.003)	-0.014*** (0.002)
<u>Province (Base: Ontario)</u>									
Atlantic Canada	0.351*** (0.056)	0.066 (0.070)	0.222*** (0.044)	-0.307 (0.252)	-0.381 (0.301)	-0.327 (0.228)	0.223** (0.107)	0.003 (0.176)	0.136 (0.095)
Quebec	0.059 (0.059)	-0.109* (0.058)	-0.024 (0.041)	0.003 (0.115)	-0.071 (0.104)	-0.028 (0.077)	0.108 (0.110)	-0.124 (0.136)	0.007 (0.085)
Manitoba	0.088 (0.067)	0.108 (0.074)	0.093* (0.050)	0.146 (0.109)	-0.001 (0.102)	0.070 (0.075)	-0.156 (0.116)	0.280* (0.148)	0.029 (0.092)

Saskatchewan	0.130 (0.062)	0.019 (0.061)	0.080* (0.044)	0.166* (0.092)	-0.006 (0.081)	0.085 (0.062)	-0.001 (0.106)	0.050 (0.125)	0.020 (0.080)
Alberta	0.193*** (0.054)	0.033 (0.063)	0.123*** (0.041)	0.214** (0.092)	0.012 (0.095)	0.114* (0.066)	0.131 (0.088)	0.137 (0.110)	0.140** (0.069)
British Columbia	0.074 (0.059)	-0.251*** (0.079)	-0.077 (0.048)	0.100 (0.207)	-0.671** (0.307)	-0.325 (0.206)	0.235** (0.111)	0.300* (0.169)	0.264*** (0.095)
Revenue Class (Base: $25,000 to $99,999)									
$100,000 to $249,999	0.584*** (0.049)	0.659*** (0.055)	0.618*** (0.036)	0.752*** (0.080)	0.778*** (0.082)	0.762*** (0.058)	0.483*** (0.071)	0.482*** (0.093)	0.479*** (0.057)
$250,000 to $999,999	1.108*** (0.052)	1.293*** (0.055)	1.196*** (0.038)	1.419*** (0.088)	1.521*** (0.082)	1.463*** (0.060)	0.710*** (0.084)	1.008*** (0.109)	0.854*** (0.068)
$1,000,000 and over	1.587*** (0.070)	1.927*** (0.070)	1.778*** (0.050)	2.012*** (0.202)	2.320*** (0.124)	2.225*** (0.103)	1.051*** (0.137)	1.058*** (0.153)	1.046*** (0.104)
Farm Type (Base: Grains & Oilseeds)									
Potato	-0.153 (0.104)	-0.309*** (0.116)	-0.232*** (0.077)						
Vegetable	-0.024 (0.094)	-0.264** (0.109)	-0.154** (0.070)						
Fruit	0.146* (0.075)	-0.246*** (0.081)	-0.058 (0.055)						
Greenhouse & Nursery	-0.132 (0.090)	-0.359*** (0.101)	-0.266*** (0.068)						
Dairy	0.658*** (0.080)	0.305*** (0.075)	0.490*** (0.055)						
Cattle	0.053 (0.049)	0.082 (0.054)	0.059 (0.036)						

Hog	-0.223***	-0.704***	-0.418***						
	(0.074)	(0.082)	(0.055)						
Poultry	-0.169***	-0.496***	-0.342***						
	(0.078)	(0.078)	(0.055)						
<u>Year (Base: changes between samples)</u>									
2003	Base Year		Base Year	Base Year		Base Year	Base Year		Base Year
2004	-0.068		-0.037	-0.113		-0.126	-0.133		-0.084
	(0.059)		(0.056)	(0.109)		(0.102)	(0.088)		(0.084)
2005	-0.297***		-0.263***	-0.451***		-0.465***	-0.331***		-0.265***
	(0.060)		(0.056)	(0.111)		(0.101)	(0.093)		(0.088)
2006[a]									
2007	-0.245***		-0.212***	-0.417***		-0.425***	-0.190**		-0.128
	(0.057)		(0.054)	(0.102)		(0.093)	(0.092)		(0.088)
2008[b]									
2009		Base Year	-0.129**		Base Year	-0.202**		Base Year	-0.141
			(0.054)			(0.095)			(0.090)
2010[c]									
2011		-0.175***	-0.311***		-0.220**	-0.426***		-0.068	-0.226**
		(0.054)	(0.052)		(0.090)	(0.087)		(0.104)	(0.089)
2013		-0.192***	-0.319***		-0.194**	-0.402***		-0.078	-0.230**
		(0.059)	(0.057)		(0.096)	(0.094)		(0.113)	(0.099)
2015		-0.270***	-0.395***		-0.428***	-0.636***		0.195	0.051
		(0.056)	(0.054)		(0.090)	(0.088)		(0.112)	(0.097)

Constant	0.365*** (0.117)	0.570*** (0.0120)	0.529*** (0.0)	0.294 (0.200)	0.485*** (0.178)	0.517*** (0.142)	0.454*** (0.163)	0.584*** (0.207)	0.556*** (0.131)
Sample Size	39035	25479	64514	8588	8117	16705	11902	5040	16942

***, **, * statistical significance at 1%, 5%, and 10% levels respectively

[a, b, c] Omitted due to missing data for survey years 2006, 2008, 2010

Table A.4: Coefficients for BRM Program Participation and Alternative Investment Variables Logit

Variable	Net Capital Investment			Net Machinery Investment			Machine Purchase		
	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled	APF	Growing Forward	Pooled
Margin Insurance	0.184*** (0.045)	0.068 (0.044)	0.118*** (0.031)	0.163*** (0.046)	0.104** (0.044)	0.126*** (0.032)	0.163*** (0.046)	0.114** (0.044)	0.131*** (0.032)
Production Insurance	0.190*** (0.043)	0.213*** (0.046)	0.195** (0.031)	0.193*** (0.043)	0.225*** (0.046)	0.203*** (0.031)	0.186*** (0.043)	0.214*** (0.046)	0.195*** (0.031)
Profit Margin	-0.122*** (0.047)	-0.219*** (0.054)	-0.163*** (0.035)	-0.178*** (0.047)	-0.182*** (0.053)	-0.176*** (0.035)	-0.165*** (0.047)	-0.163*** (0.051)	-0.161*** (0.034)
Diversity Index	0.069*** (0.013)	0.042*** (0.010)	0.051*** (0.008)	0.042*** (0.012)	0.037*** (0.009)	0.037*** (0.007)	0.041*** (0.012)	0.035*** (0.009)	0.036*** (0.007)
Debt-to-TGR	-0.602*** (0.092)	-0.677*** (0.102)	-0.627*** (0.068)	-0.689*** (0.092)	-0.838*** (0.102)	-0.742*** (0.068)	-0.670*** (0.092)	-0.836*** (0.101)	-0.731*** (0.068)
Liquidity	0.105*** (0.029)	0.021 (0.019)	0.051** (0.022)	0.103*** (0.028)	0.040 (0.026)	0.065*** (0.022)	0.120*** (0.029)	0.044 (0.027)	0.073*** (0.023)
Years of Management Experience	-0.009*** (0.002)	-0.013*** (0.001)	-0.011*** (0.001)	-0.008*** (0.002)	-0.010*** (0.001)	-0.009*** (0.001)	-0.008*** (0.002)	-0.009*** (0.001)	-0.009*** (0.001)
<u>Province (Base: Ontario)</u>									
Atlantic Canada	0.336*** (0.055)	0.092 (0.068)	0.227*** (0.043)	0.356*** (0.054)	0.127* (0.066)	0.256*** (0.042)	0.331*** (0.054)	0.084 (0.066)	0.223*** (0.042)
Quebec	0.092 (0.058)	-0.071 (0.057)	0.012 (0.041)	-0.210*** (0.058)	-0.301*** (0.058)	-0.254*** (0.041)	-0.216*** (0.059)	-0.316*** (0.058)	-0.264*** (0.041)
Manitoba	0.080 (0.065)	0.125* (0.073)	0.098** (0.049)	0.051 (0.065)	0.185*** (0.071)	0.109** (0.048)	0.063 (0.065)	0.164** (0.071)	0.106** (0.048)

Saskatchewan	0.094 (0.062)	0.035 (0.060)	0.069 (0.043)	0.089 (0.062)	0.092 (0.061)	0.092** (0.044)	0.086 (0.062)	0.052 (0.061)	0.071 (0.044)
Alberta	0.169*** (0.053)	0.035 (0.062)	0.114*** (0.040)	0.153*** (0.053)	0.111* (0.062)	0.138*** (0.040)	0.148*** (0.053)	0.094 (0.062)	0.127*** (0.040)
British Columbia	0.082 (0.058)	-0.210*** (0.079)	-0.053 (0.048)	-0.013 (0.058)	-0.204** (0.083)	-0.101** (0.048)	-0.005 (0.058)	-0.187** (0.083)	-0.089* (0.048)
Revenue Class (Base: $25,000 to $99,999)									
$100,000 to $249,999	0.551*** (0.048)	0.636*** (0.055)	0.588*** (0.036)	0.643*** (0.049)	0.700*** (0.058)	0.669*** (0.037)	0.624*** (0.049)	0.676*** (0.058)	0.648*** (0.038)
$250,000 to $999,999	1.000*** (0.051)	1.234*** (0.055)	1.113*** (0.037)	1.152*** (0.051)	1.335*** (0.057)	1.240*** (0.038)	1.142*** (0.051)	1.292*** (0.057)	1.214*** (0.038)
$1,000,000 and over	1.501*** (0.066)	1.821*** (0.068)	1.674*** (0.048)	1.651*** (0.065)	1.945*** (0.068)	1.815*** (0.048)	1.589*** (0.065)	1.866*** (0.068)	1.747*** (0.047)
Farm Type (Base: Grains & Oilseeds)									
Potato	-0.114 (0.101)	-0.307*** (0.113)	-0.212*** (0.075)	-0.080 (0.099)	-0.193* (0.108)	-0.140* (0.073)	-0.087 (0.098)	-0.168 (0.107)	-0.131* (0.072)
Vegetable	0.043 (0.092)	-0.253** (0.108)	-0.114 (0.070)	-0.115 (0.087)	-0.304*** (0.102)	-0.216*** (0.066)	-0.119 (0.087)	-0.315*** (0.102)	-0.222*** (0.066)
Fruit	0.190** (0.073)	-0.205** (0.080)	-0.016 (0.054)	-0.125* (0.074)	-0.496*** (0.082)	-0.308*** (0.055)	-0.134* (0.073)	-0.508*** (0.082)	-0.319*** (0.054)
Greenhouse & Nursery	-0.038 (0.088)	-0.304*** (0.100)	-0.194*** (0.067)	-0.541*** (0.085)	-0.575*** (0.109)	-0.580*** (0.069)	-0.557*** (0.085)	-0.660*** (0.111)	-0.628*** (0.069)
Dairy	0.516*** (0.077)	0.263*** (0.073)	0.393*** (0.053)	0.305*** (0.073)	0.006 (0.070)	0.166*** (0.051)	0.306*** (0.072)	0.005 (0.070)	0.166*** (0.051)
Cattle	-0.031 (0.048)	-0.029 (0.053)	-0.038 (0.036)	-0.137*** (0.049)	-0.158*** (0.054)	-0.151*** (0.036)	-0.126*** (0.049)	-0.155*** (0.054)	-0.144*** (0.036)

Hog	-0.150**	-0.654***	-0.354***	-0.549***	-1.042***	-0.739***	-0.543***	-1.008***	-0.723***
	(0.072)	(0.081)	(0.055)	(0.073)	(0.083)	(0.056)	(0.073)	(0.083)	(0.056)
Poultry	-0.136*	-0.501***	-0.328***	-0.460***	-0.754***	-0.613***	-0.439***	-0.721***	-0.586***
	(0.077)	(0.077)	(0.055)	(0.078)	(0.080)	(0.056)	(0.078)	(0.080)	(0.056)
Year (Base: changes between samples)									
2003	Base Year		Base Year	Base Year		Base Year	Base Year		Base Year
2004	-0.016		0.018	-0.004		0.014	0.002		0.017
	(0.057)		(0.055)	(0.057)		(0.055)	(0.057)		(0.055)
2005	-0.234***		-0.198***	-0.281***		-0.261***	-0.290***		-0.274***
	(0.058)		(0.055)	(0.059)		(0.056)	(0.059)		(0.056)
2006[a]									
2007	-0.158***		-0.124**	-0.208***		-0.192***	-0.211***		-0.196***
	(0.055)		(0.052)	(0.055)		(0.052)	(0.055)		(0.052)
2008[b]									
2009		Base Year	-0.041		Base Year	-0.152***		Base Year	-0.161***
			(0.053)			(0.053)			(0.053)
2010[c]									
2011		0.101*	-0.187***		0.132**	-0.322***		0.133**	-0.349***
		(0.052)	(0.051)		(0.052)	(0.051)		(0.056)	(0.051)
2013		0.043	-0.235***		0.064	-0.381***		0.070	-0.404***
		(0.057)	(0.056)		(0.058)	(0.057)		(0.052)	(0.057)
2015[d]		Omitted	-0.277***		Omitted	-0.445***		Omitted	-0.473***
			(0.053)			(0.053)			(0.054)

Constant	0.094 (0.115)	0.137 (0.122)	0.259*** (0.087)	-0.057 (0.114)	-0.267** (0.112)	0.058 (0.086)	-0.111 (0.114)	-0.320*** (0.122)	0.018 (0.086)
Sample Size	39035	25479	64514	39035	25479	64514	39035	25479	64514

***, **, * statistical significance at 1%, 5%, and 10% levels respectively

[a, b, c] Omitted due to missing data for survey years 2006, 2008, 2010

[d] 2015 is omitted due to collinearity